HIRSCHMANN
A Belden Company

User Manual

Redundancy Configuration
Industrial ETHERNET (Gigabit) Switch
RS20/RS30/RS40, MS20/MS30, OCTOPUS

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Content

About this Manual

The “Redundancy Configuration” user manual contains all the information you need to select a suitable redundancy procedure and configure it.

The “Basic Configuration” user manual contains all the information you need to start operating the device. It takes you step by step from the first startup operation through to the basic settings for operation in your environment.

The “Installation” user manual contains a device description, safety instructions, a description of the display, and all the other information that you need to install the device before you begin with the configuration of the device.

The “Industry Protocols” user manual describes how the device is connected by means of a communication protocol commonly used in the industry, such as EtherNet/IP and PROFINET.

The "Web-based Interface" reference manual contains detailed information on using the Web interface to operate the individual functions of the device.

The "Command Line Interface" reference manual contains detailed information on using the Command Line Interface to operate the individual functions of the device.

The Network Management Software HiVision provides you with additional options for smooth configuration and monitoring:

- Event logbook.
- Configuration of „System Location“ and „System Name“.
- Configuration of the network address range and SNMP parameters.
- Saving the configuration on the device.
- Simultaneous configuration of multiple devices.
- Configuration of the port display color red for a connection error.

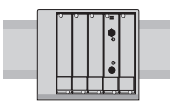
Key

The designations used in this manual have the following meanings:

▶	List
☐	Work step
■	Subheading
Link	Indicates a cross-reference with a stored link
Note:	A note emphasizes an important fact or draws your attention to a dependency.
`Courier`	ASCII representation in user interface
	Execution in the Web-based Interface user interface
	Execution in the Command Line Interface user interface

Symbols used:

	Router with firewall
	Switch with firewall
	Router
	Switch
	Bridge
	Hub

	A random computer
	Configuration Computer
	Server
	PLC - Programmable logic controller
	I/O - Robot

1 Introduction

The device contains a range of redundancy functions:

- HIPER-Ring
- Redundant coupling of HIPER-Rings and network segments
- Rapid Spanning Tree Algorithm (RSTP)

Three tools are available for operating these functions:

- Web-based Management (supplied with the Switch)
  for convenient agent configuration (see Reference Manual - Web-based Interface).
- Command Line Interface (supplied with the Switch)
  for setting elementary functions (see reference manual – Command Line Interface).
- HiVision Network Management
  for convenient cross-agent configuration
  (see manual – HiVision Hirschmann Network Management).

1.1 Comparison of the redundancy procedures

	RSTP	HIPER-Ring Version 1, 2	HIPER-Ring Version 3	Redundant coupling	Link aggregation
Switching time	< 30 s, typically < 1 s (STP < 30 s) depends heavily on the number of Switches	< 0.5 s Practically independent of the number of Switches	< 10 ms With 5 Switches in the ring. With more than 5 Switches, the switching time increases.	typically 0.15 s	-
Network topology	Random structure	Ring	Ring	Coupling of network segment/rings via a main line and a redundant line	Coupling of network segments via multiple active lines with dynamic load distribution

Table 1: Features of the redundancy procedures

2 HIPER-Ring

The concept of the HIPER-Ring enables the construction of high-availability, ring-shaped network structures.
Using the RM function (**R**edundancy **M**anager) of a Switch with the L2E, L2P, L3E or L3P software, you can close both ends of a backbone in a line structure to a redundant ring, the HIPER-Ring (see fig. 1).

Within a HIPER-Ring Version 1, any combination of RS1, RS2-../.., RS2-16M, RS2-4R, RS20, RS30, RS40, MICE, PowerMICE, MS 20, MS 30, RSR20, RSR30, MACH 1000, MACH 3000 and MACH 4000 is possible.
Within a HIPER-Ring Version 2 (MRP Draft), any combination of devices that support this function is possible.
Within a HIPER-Ring Version 3, any combination of RSR20, RSR30 and MACH 1000 is possible.

If a section is down, the ring structure of a

- HIPER-Ring Version 1 of up to 50 devices typically transforms back to a line structure within 150 ms (adjustable to max. 300 ms/500 ms).
- HIPER-Ring Version 2 of up to 50 devices typically transforms back to a line structure within 150 ms (adjustable to max. 200 ms/500 ms).
- HIPER-Ring Version 3 of up to 5 devices typically transforms back to a line structure within 5 ms (maximum 10 ms). If a larger number of devices is being used, the reconfiguration time increases.

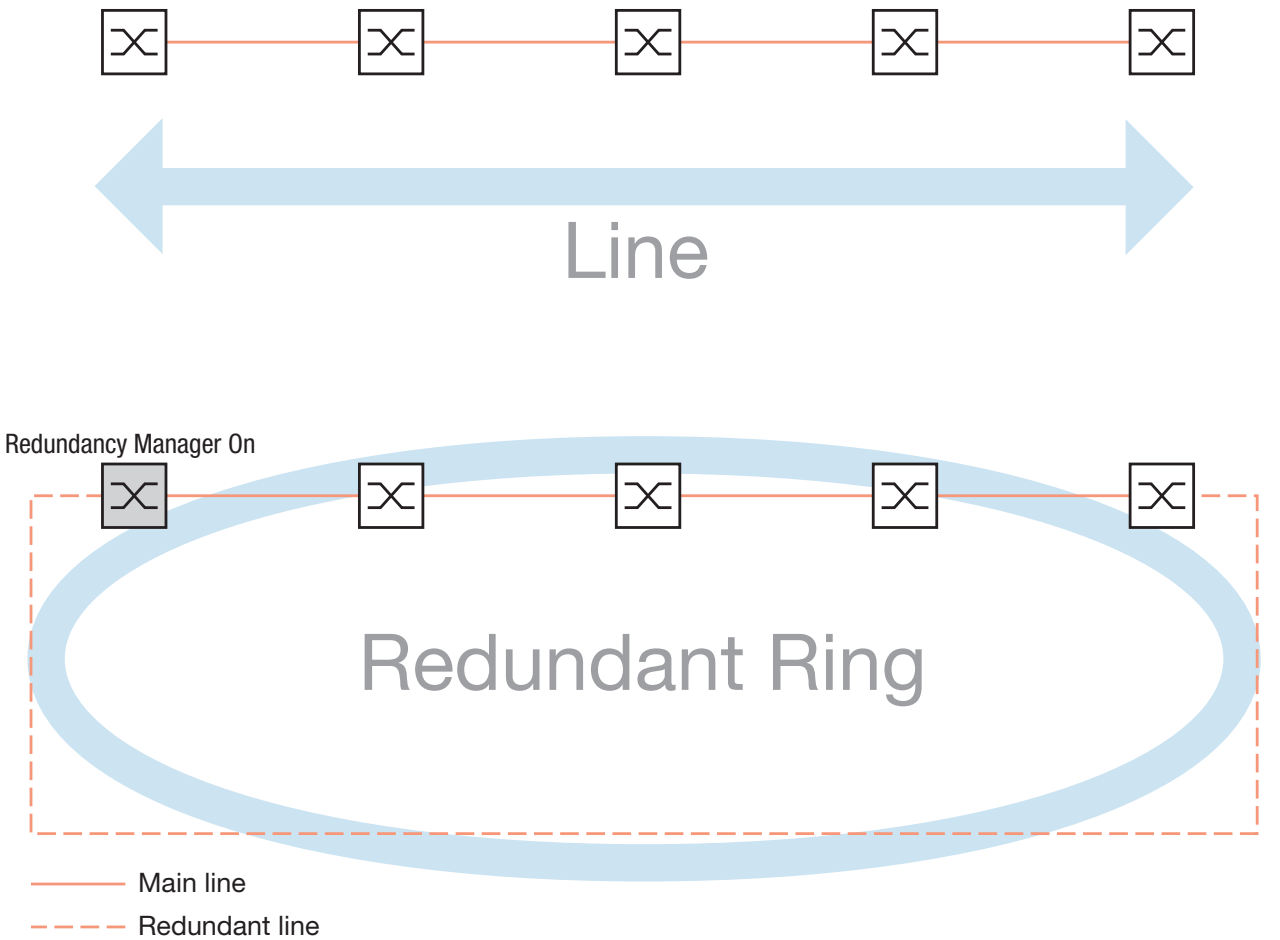


Figure 1: Line and redundant ring

2.1 Configuring HIPER-Ring Version 1

☐ Set up the network to meet your requirements.

Note: Before you connect the redundant line, you must complete the configuration of HIPER-Ring Version 1.
You thus avoid loops during the configuration phase.

Note: Configure each HIPER-Ring device.

☐ Select the `Redundancy:HIPER-Ring` dialog.

☐ Select `Version 1`.

Note: As an alternative to using software to configure HIPER-Ring Version 1, with devices RS20/30/40 and MS20/30 you can also use a DIP switch to enter a number of settings for HIPER-Ring Version 1. You can also use this DIP switch to enter a setting for whether the configuration via DIP switch or the configuration via software has priority. The state on delivery is “Software Configuration”.

☐ For each device, you enter the desired ring ports 1 and 2.
The following settings are required for the ring ports (select the `Basic Settings:Port Configuration` dialog):

Bit rate	100 Mbit/s	1000 Mbit/s
Autonegotiation (automatic configuration)	Off	On
Port	On	On
Duplex	Full	–

Table 2: Port settings for ring ports

Note: When using 100 Mbit/s with twisted pair cables, avoid the combination of autonegotiation “off” and cable crossing “automatic”. Use crossover cables with 100 Mbit/s.

Display in “Operation” field:
Active: this port is switched on and has a link.
Inactive: this port is switched off or has no link.

☐ At exactly one device, you switch the redundancy manager on at the ends of the line.

☐ Select the desired value in the “Ring Recovery” frame for the device for which you have activated the redundancy manager.

Note: Settings in the “Ring Recovery” frame are ineffective for devices that are not the redundancy manager.

Note: If selecting the smaller value for the ring recovery does provide the ring stability neccesary to meet the requirements of your network, you select 500 ms.

Figure 2: Selecting HIPER-Ring version, entering ring ports, enabling/ disabling redundancy manager and selecting ring recovery

Note: Deactivate the Spanning Tree protocol for the ports connected to the redundant ring, because the Spanning Tree and the Ring Redundancy work with different reaction times.

Note: If you used the DIP switch to activate the function of HIPER-Ring Version 1, RSTP is automatically switched off.

☐ Now you connect the line to the ring. To do this, you connect the two devices to the ends of the line using their ring ports.

The displays in the “Redundancy Manger Status” frame mean:

– “Active (redundant line)”: The ring is open, which means that a data line or a network component within the ring is down.
– “Inactive”: The ring is closed, which means that the data lines and network components are working.

The displays in the “Information” frame mean:

– „“Redundancy guaranteed”: One of the lines affected by the function can fail, whereby the redundant line will then take over the function of the failed line.
– „“Configuration failure”: The function is incorrectly configured or there is an error on ringport link.

Figure 3: Display: Redundancy Manager Status and Information

Note: If VLANS are configured, note the VLAN configuration of the ring ports.
In the configuration of HIPER-Ring Version 1, you select for the ring ports

– VLAN ID 1 and
– VLAN membership U in the static VLAN table

Note: When you switch from a normal port to a ring port with the DIP switch, the device makes the required settings for the ring ports in the configuration table. The port which has been switched from a ring port to a normal port keeps the ring port settings. These settings remain changeable for all ports.

2.2 Configuring HIPER-Ring Version 2 (MRP Draft)

☐ Set up the network to meet your requirements.

Note: Before you connect the redundant line, you must complete the configuration of HIPER-Ring Version 2.
You thus avoid loops during the configuration phase.

Note: Configure each HIPER-Ring device.

☐ Select the `Redundancy:HIPER-Ring` dialog.
☐ Select `Version 2 (MRP Draft).`
☐ For each device, you enter the desired ring ports 1 and 2.
The following settings are required for the ring ports (select the `Basic Settings:Port Configuration` dialog):

Bit rate	100 Mbit/s	1000 Mbit/s
Autonegotiation (automatic configuration)	Off	On
Port	On	On
Duplex	Full	–

Table 3: Port settings for ring ports

Note: When using 100 Mbit/s with twisted pair cables, avoid the combination of autonegotiation “off” and cable crossing “automatic”. Use crossover cables with 100 Mbit/s.

Display in “Operation” field:
forwarding: this port is switched on and has a link.
blocked: this port is blocked and has a link.
disabled: this port is switched off
not connected: this port has no link.

☐ At exactly one device, you switch the redundancy manager on at the ends of the line.

Figure 4: Selecting HIPER-Ring version, entering ring ports and enabling/ disabling redundancy manager

☐ If a device in the ring does not support the advanced mode for fast switching times, you deactivate the advanced mode in the redundancy manager, in the “Configuration Redundancy Manager” frame. All Hirschmann devices that support the HIPER-Ring Version 2 (MRP Draft) also support the advanced mode.

Note: Deactivate the Spanning Tree protocol for the ports connected to the redundant ring, because the Spanning Tree and the Ring Redundancy work with different reaction times.

The “VLAN” frame enables you to assign HIPER-Ring Version 2 to a VLAN.

☐ If VLANs are configured, then in the “VLAN” frame you select
- VLAN ID 0, if the MRP-Ring configuration is not to be assigned to a VLAN.
Note the VLAN configuration of the ring ports. Then select for the ring ports
- VLAN ID 1 and
- VLAN membership U in the static VLAN table
- a VLAN ID >0, if the MRP-Ring configuration is to be assigned to this VLAN.
Select this VLAN ID in the MRP-Ring configuration for all devices in this MRP-Ring.
Note the VLAN configuration of the ring ports. For all ring ports in this MRP-Ring, select
- this VLAN ID and
- VLAN membership U in the static VLAN table.

☐ Select the desired value in the “Ring Recovery” frame for the device for which you have activated the redundancy manager.

Note: Settings in the “Ring Recovery” frame are ineffective for devices that are not the redundancy manager.

Note: If selecting the smaller value for the ring recovery does provide the ring stability neccesary to meet the requirements of your network, you select 500 ms.

☐ Activate the function in the “Operation” frame.

☐ Now you connect the line to the ring. To do this, you connect the two devices to the ends of the line using their ring ports.

The displays in the “Information” frame mean:

– „“Redundancy guaranteed”: One of the lines affected by the function can fail, whereby the redundant line will then take over the function of the failed line.

– „“Configuration failure”: The function is incorrectly configured or there is an error on ringport link.

Figure 5: Configuring the Redundancy Manager, selecting operation, selecting ring recovery and entering VLAN ID. Display: Information.

3 Redundant coupling

3.1 The variants of redundant coupling

The control intelligence built into the Switch enables the redundant coupling of HIPER-Rings and network segments. Two rings/network segments are connected using two separate paths with one of the following Switches:

- RS2-16M,
- RS20, RS30, RS40,
- MICE (from rel. 3.0) or
- PowerMICE,
- MS 20, MS 30,
- RSR20, RSR30,
- MACH 1000,
- MACH 3000 (from rel. 3.3),
- MACH 4000.

The redundant coupling is effected by the **one-Switch coupling** of two ports of **one** Switch in the first ring/network segment, to one port each of two Switches in the second ring/network segment (see fig. 7).
Immediately after the main line fails, the Switch opens the redundant line. When the main line is OK again, the main line is opened again and the redundant line is blocked again.
An error is detected and eliminated within 500 ms (typically 150 ms).

The redundant coupling is effected by the **two-Switch coupling** of one port each from **two** Switches in the first ring/network segment, to one port each of two Switches in the second ring/network segment (see fig. 13).
The Switch in the redundant line and the Switch in the main line use control packets to inform each other about their operating states, via the Ethernet or the control line.
Immediately after the main line fails, the redundant Switch releases the redundant line. As soon as the main line is restored to normal operation, the Switch in the main line informs the redundant Switch. The main line is released again, and the redundant line is blocked again.
An error is detected and eliminated within 500 ms (typically 150 ms).

The type of coupling primarily depends on the topological conditions and the desired level of safety (see table 4).

	One-Switch coupling	Two-Switch coupling	Two-Switch coupling with control line
Use	The two Switches are in impractical topological positions. Putting the lines down between them would involve a lot of work for two-Switch coupling.	The two Switches are in practical topological positions. Putting down a control line would involve a lot of work.	The two Switches are in practical topological positions. Putting down a control line would not involve much work.
Disadvantage	If the Switch configured for the redundant coupling fails, no connection remains between the networks.	Much work involved in connecting the two Switches to the network (compared with one-Switch coupling).	Much work involved in connecting the two Switches to the network (compared with one-Switch and two-Switch coupling).
Advantage	Less work involved in connecting the two Switches to the network (compared with two-Switch coupling).	If one of the Switches configured for the redundant coupling fails, there is still a connection between the networks.	If one of the Switches configured for the redundant coupling fails, there is still a connection between the networks.

Table 4: Selection criteria for the variants of the redundant coupling

3.2 Configuring the redundant coupling

3.2.1 STAND-BY switch

The Switches have a STAND-BY switch for selecting between the main coupling and the redundant coupling. Depending on the Switch, this switch is a DIP switch or a software switch (`Redundancy:Ring/Network Coupling` dialog), or you can use a switch to select one of the two options.

Switch	STAND-BY switch
RS2-../..	DIP switch
RS2-16M	DIP switch
RS20/RS30/RS40	Can be switched between DIP switch and software switch
MICE/PowerMICE	Can be switched between DIP switch and software switch
MS 20/MS 30	Can be switched between DIP switch and software switch
RSR20/RSR30	Software switch
MACH 1000	Software switch
MACH 3000/MACH 4000	Software switch

Table 5: STAND-BY switches of the Switches

Depending on the Switch used, you choose between the main coupling and the redundant coupling (see table 6).

Switch with	Choice of main coupling or redundant coupling
DIP switch	“STAND-BY” on DIP switch
DIP switch/software switch option	According to the option selected - “Stand-by” on the DIP switch or in the - `Redundancy:Ring/Network Coupling` dialog, by selecting in “Select configuration”. **Note:** These devices have a DIP switch, with which you can choose between the software configuration and the DIP configuration. If the software configuration is set, the other DIP switches have no effect.
Software switch	In the `Redundancy:Ring/Network Coupling` dialog

Table 6: Choice of main coupling or redundant coupling

☐ Select the `Redundancy:Ring/Network Coupling` dialog.

☐ You first select the configuration you want: One-Switch coupling (“1”), two-Switch coupling (“2”) or two-Switch coupling with control line (“3”), (see fig. 6).

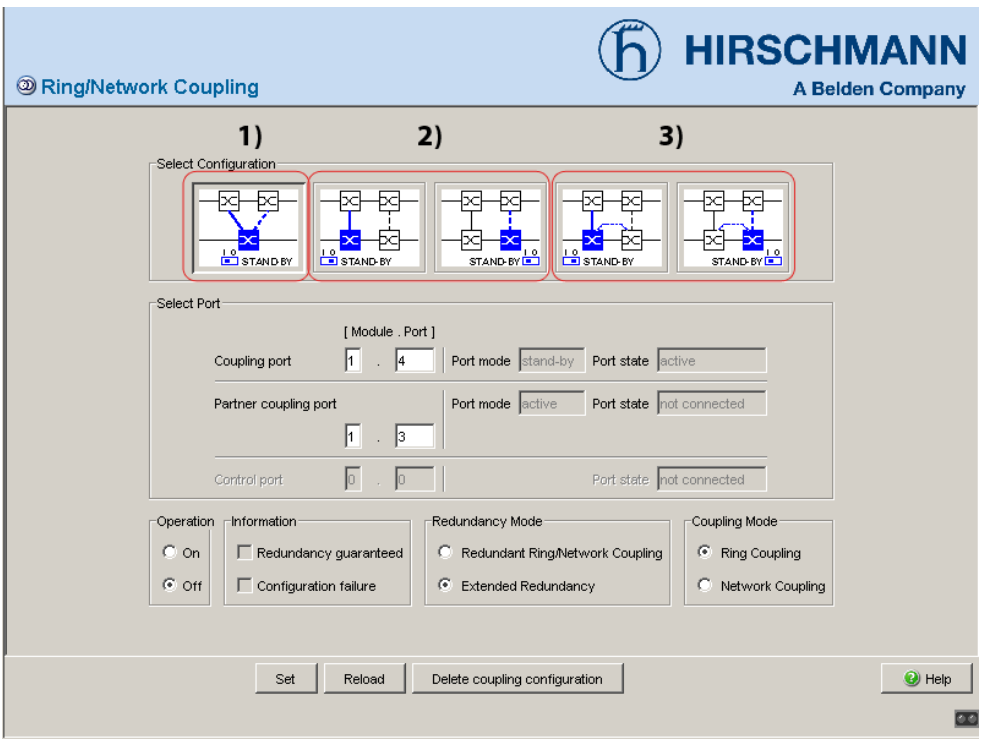


Figure 6: Selecting the configuration

Note: Depending on the STAND-BY DIP switch position, the dialog displays those configurations that are not possible in gray. If you want to select one of these grayed-out configurations, you put the STAND-BY DIP switch on the Switch into the other position.

Note: One-Switch coupling: The redundancy function is assigned to the Switch via the “STAND-BY” setting in the DIP switch, or via the Management.

Note: Two-Switch coupling: The redundancy function is assigned to the Switch in the redundant line via the “STAND-BY” setting in the DIP switch, or via the Management.

Note: Some devices have a DIP switch, with which you can choose between the software configuration and the DIP configuration. If the software configuration is set, the other DIP switches have no effect.

Note: The choice of configuration primarily depends on the topological conditions and the desired level of security (see table 4).

Note: For redundancy security reasons, a combination of Rapid Spanning Tree and Ring/Network Coupling is not possible.

3.2.2 One-Switch coupling

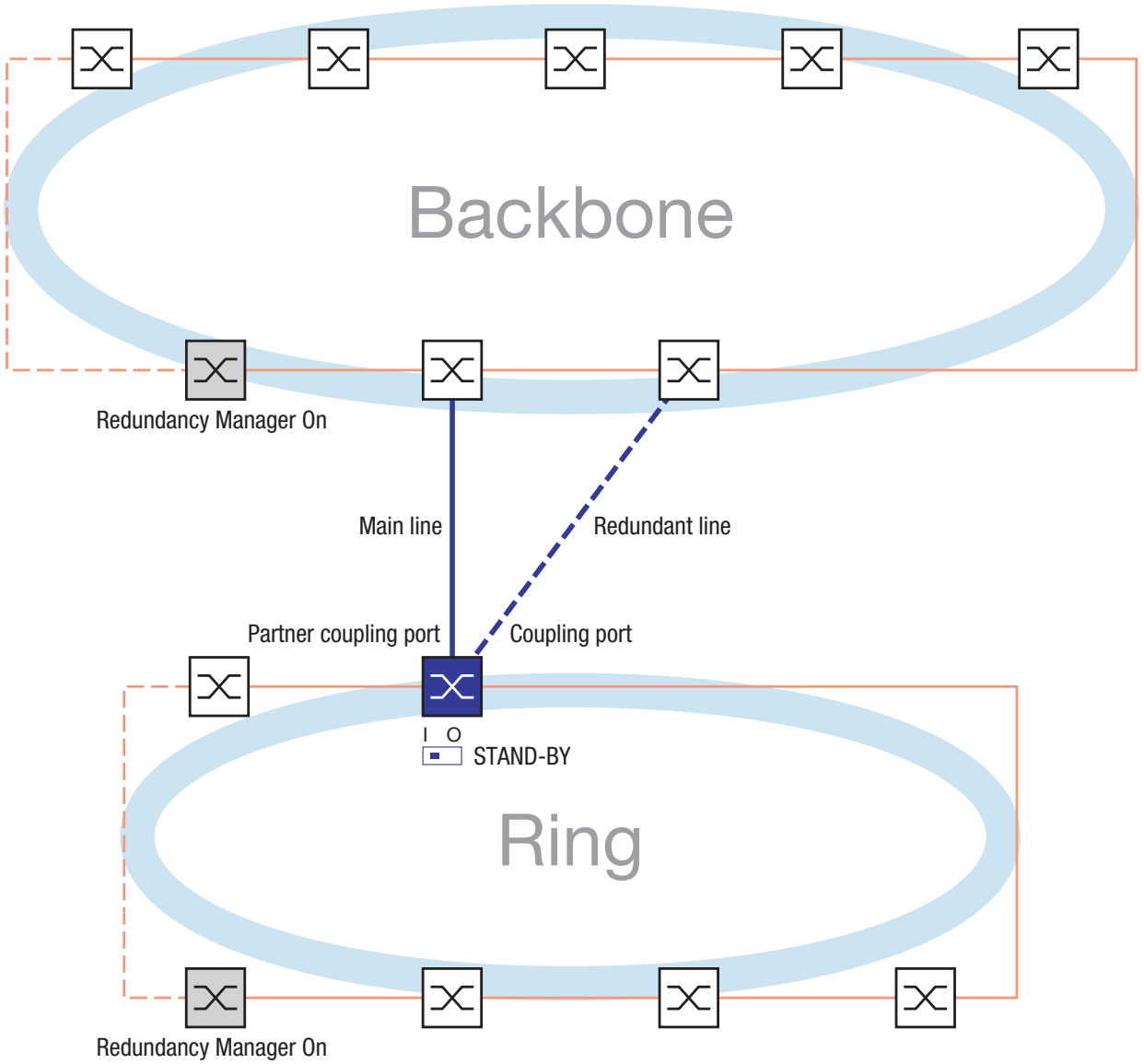


Figure 7: Example of one-Switch coupling

The coupling between two networks is effected by the main line (thick blue line), which is connected to the partner coupling port. If the main line fails, the redundant line (thick blue dotted line), which is connected to the coupling port, takes over coupling the two networks. The coupling is effected by **one** Switch.

☐ Select the `Redundancy:Ring/Network Coupling` dialog.
☐ Select one-Switch coupling (see fig. 8).

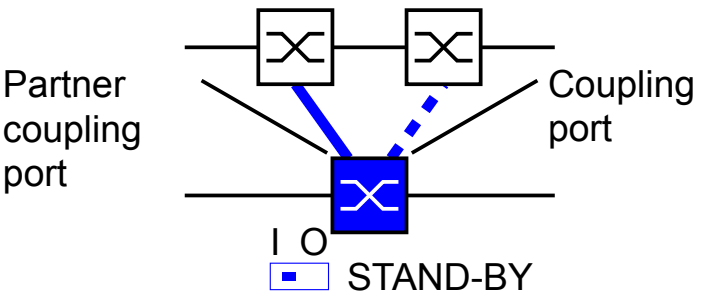


Figure 8: One-Switch coupling

The following settings apply to the Switch displayed in blue in the selected graphic.

☐ Select the partner coupling port (see fig. 9), (see table 7).
With “Partner coupling port” you specify at which port you are connecting the control line.

Switch	Partner coupling port
RS2-../..	Not possible
RS2-16M	Adjustable for all ports (default setting: port 2)
RS20	Adjustable for all ports (default setting: port 1.3)
RS30	Adjustable for all ports (default setting: port 1.3)
RS40	Adjustable for all ports (default setting: port 1.3)
MICE	Adjustable for all ports (default setting: port 1.3)
PowerMICE	Adjustable for all ports (default setting: port 1.3)
MS 20	Adjustable for all ports (default setting: port 1.3)
MS 30	Adjustable for all ports (default setting: port 2.3)
RSR20/30	Adjustable for all ports (default setting: port 1.3)
MACH 1000	Adjustable for all ports (default setting: port 1.3)
MACH 3000	Adjustable for all ports
MACH 4000	Adjustable for all ports (default setting: port 1.3)

Table 7: Port assignment for one-Switch coupling

Note: Configure the partner coupling port and the HIPER-Ring ports on different ports.

☐ Select the coupling port (see fig. 9), (see table 8).
With “Coupling port” you specify at which port you are connecting the redundant line.

Switch	Coupling port
RS2-../..	Not possible
RS2-16M	Adjustable for all ports (default setting: port 1)
RS20	Adjustable for all ports (default setting: port 1.4)
RS30	Adjustable for all ports (default setting: port 1.4)
RS40	Adjustable for all ports (default setting: port 1.4)
MICE	Adjustable for all ports (default setting: port 1.4)
PowerMICE	Adjustable for all ports (default setting: port 1.4)
MS 20	Adjustable for all ports (default setting: port 1.4)
MS 30	Adjustable for all ports (default setting: port 2.4)
RSR20/30	Adjustable for all ports (default setting: port 1.4)
MACH 1000	Adjustable for all ports (default setting: port 1.4)
MACH 3000	Adjustable for all ports
MACH 4000	Adjustable for all ports (default setting: port 1.4)

Table 8: Port assignment for one-Switch coupling

Note: Configure the coupling port and the HIPER-Ring ports on different ports.

☐ Activate the function in the “Operation” frame (see fig. 9).

☐ You now connect the redundant line.

The displays in the “Select port” frame mean (see fig. 9):

– “Port mode”: The port is either active or in stand-by mode.
– “Port state”: The port is either connected or not connected.

The displays in the “Information” frame mean (see fig. 9):

– “Redundancy guaranteed”: One of the lines affected can fail, as a redundant line will then take over the function of the failed line.
– “Configuration failure”: The function is incomplete or incorrectly configured.

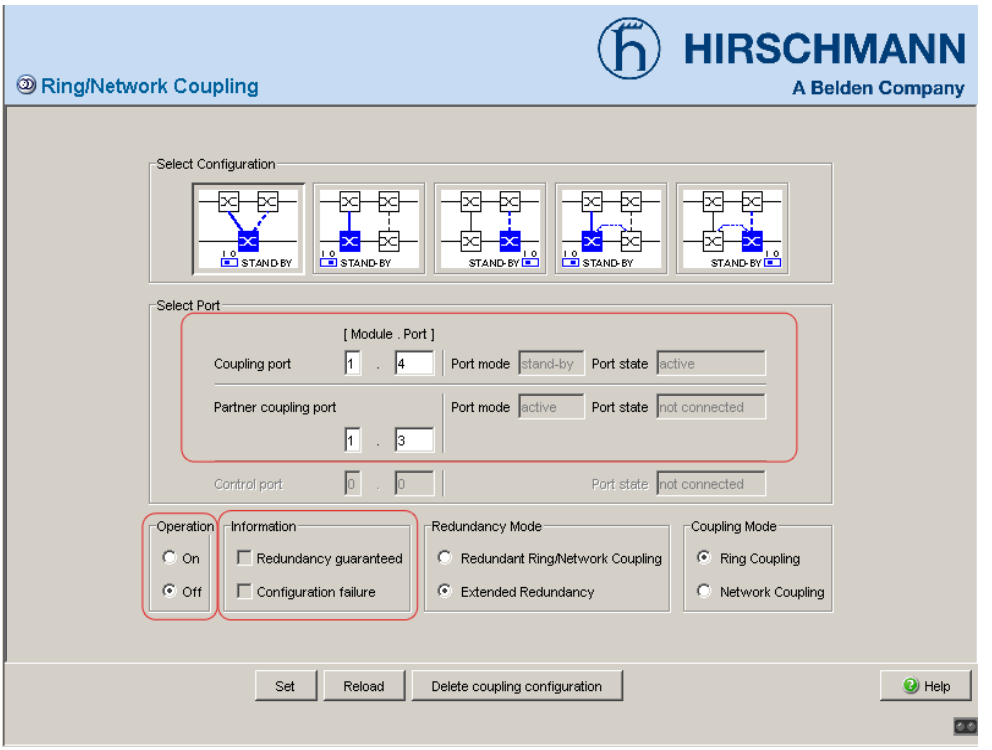


Figure 9: Selecting the port and enabling/disabling operation

Note: The following settings are required for the coupling ports (you select the `Basic Settings:Port Configuration` dialog):
– Port: on
– Automatic configuration (autonegotiation): on for twisted-pair connections
– Manual configuration: 100 Mbit/s FDX for glass fiber connections

Note: If VLANS are configured, note the VLAN configuration of the coupling and partner coupling ports.
In the Network/Ring Coupling configuration, select for the coupling and partner coupling ports
– VLAN ID 1 and “Ingress Filtering” disabled in the port table and
– VLAN membership `U` in the static VLAN table.

Redundancy mode

☐ In the “Redundancy Mode” frame, select (see fig. 10)
– “Redundant Ring/Network Coupling” or
– “Extended Redundancy”.

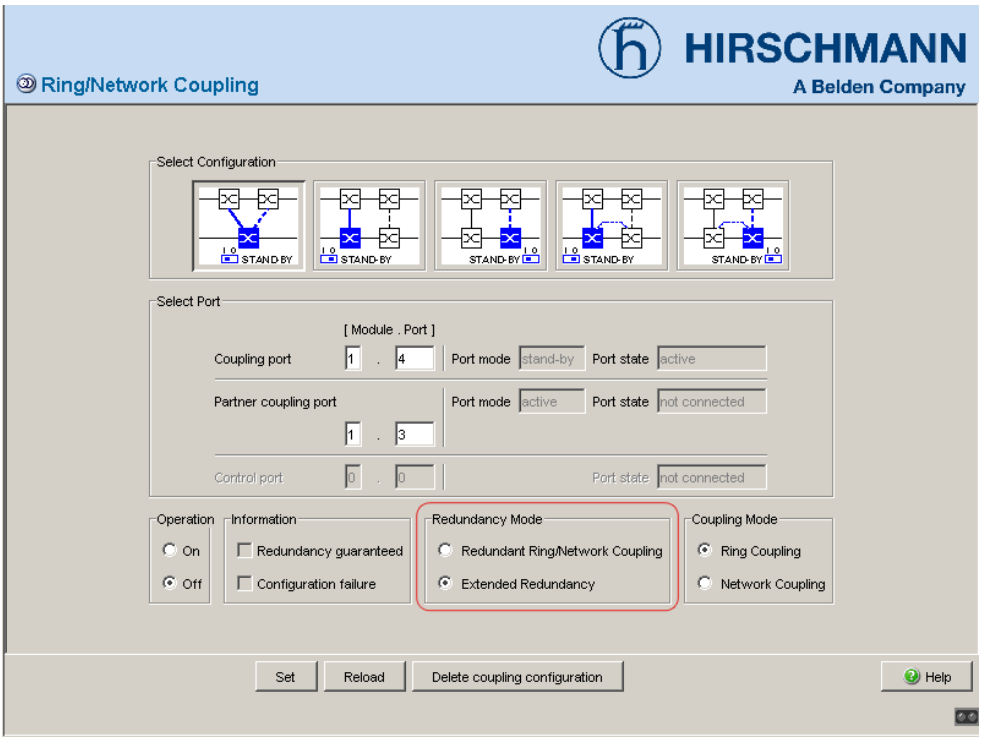


Figure 10: Selecting the redundancy mode

With the “Redundant Ring/Network Coupling” setting, either the main line or the redundant line is active. Both lines are never active simultaneously.

With the “Extended Redundancy” setting, the main line and the redundant line are simultaneously active if the connection line between the Switches in the connected network fails (see fig. 11).

During the reconfiguration period, there may be package duplications. Therefore, only select this setting if your application detects package duplications.

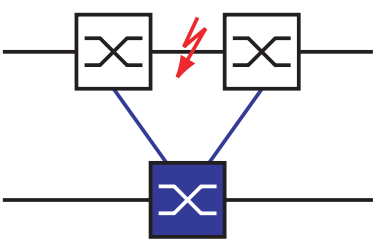


Figure 11: Extended redundancy

Coupling mode

The coupling mode indicates the type of the connected network.

☐ In the “Coupling Mode” frame, select (see fig. 12)

– “Ring Coupling” or

– “Network Coupling”

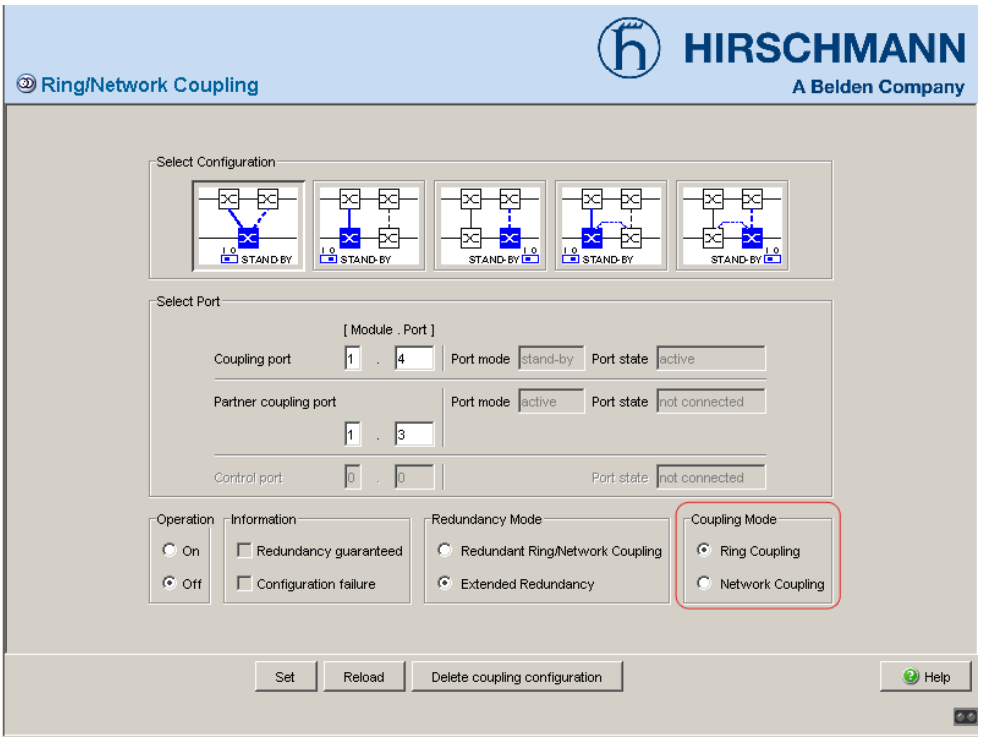


Figure 12: Selecting the coupling mode

☐ Select **“Ring coupling”** if you are connecting a HIPER-Ring.

☐ Select **“Network Coupling”** if you are connecting a line structure.

Delete coupling configuration

☐ The “Delete coupling configuration” button in the dialog allows you to reset all the coupling settings of the device to the state on delivery.

3.2.3 Two-Switch coupling

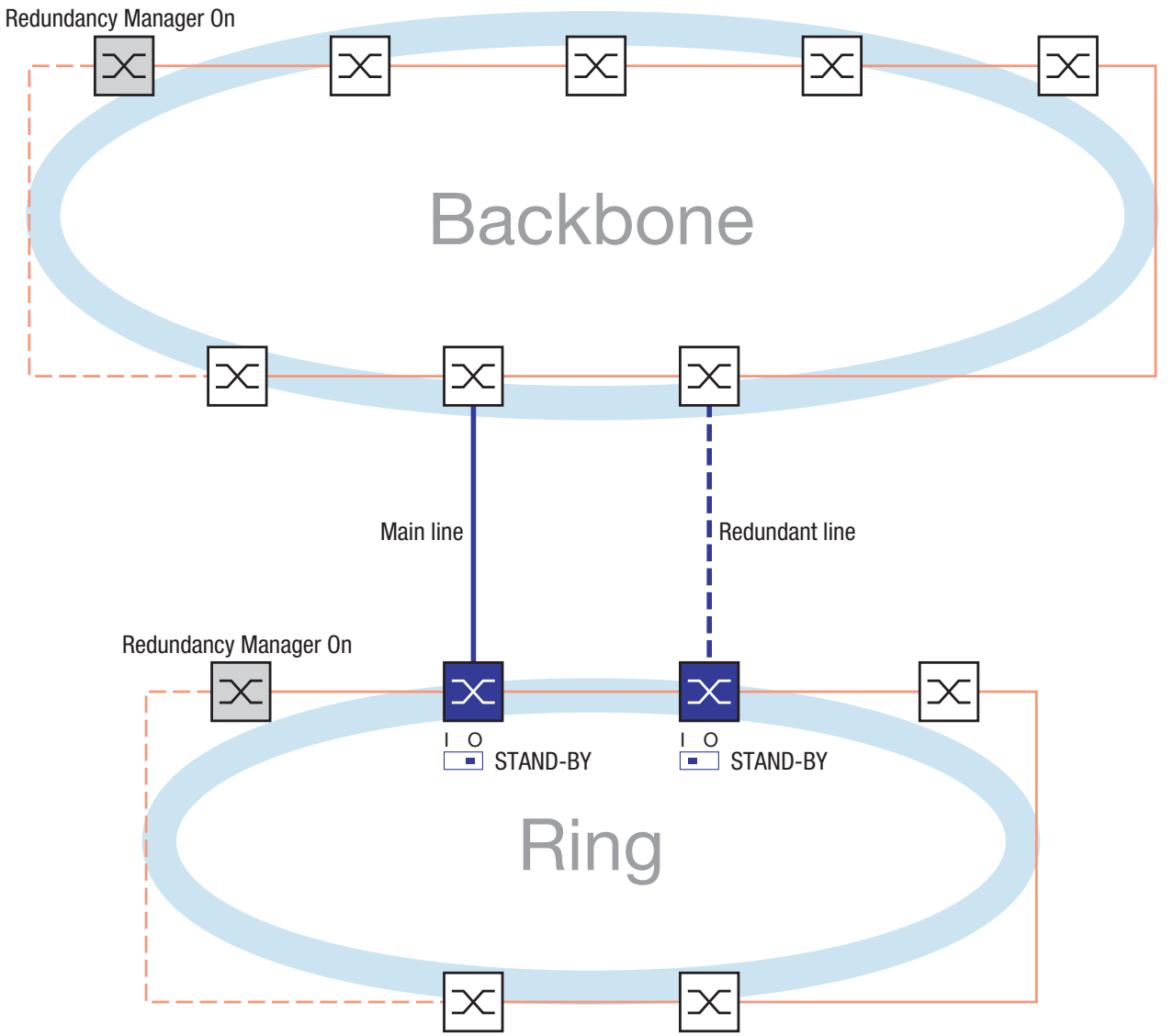


Figure 13: Example of two-Switch coupling

The coupling between two networks is effected by the main line (thick blue line). If the main line fails, the redundant line (thick blue dotted line) takes over coupling the two networks.
The coupling is effected by two Switches.
The switches send their control packages via the Ethernet.
The Switch to which you connect the main line, and the Switch to which you connect the redundant line, are partners as regards the coupling.

☐ Connect the two partners via their ring ports.

☐ Select the `Redundancy:Ring/Network Coupling` dialog.

☐ Select two-Switch main coupling (see fig. 14).

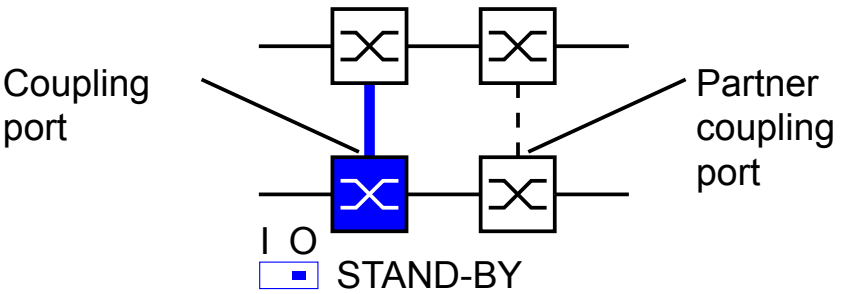


Figure 14: Two-Switch coupling

The following settings apply to the Switch displayed in blue in the selected graphic.

☐ Select the coupling port (see fig. 15), (see table 9).
With “Coupling port” you specify at which port you are connecting the redundant line.

☐ If the STANDBY DIP switch is OFF, connect the main line to the coupling port.

Switch	Coupling port
RS2-../..	Not possible
RS2-16M	Adjustable for all ports (default setting: port 1)
RS20	Adjustable for all ports (default setting: port 1.4)
RS30	Adjustable for all ports (default setting: port 1.4)
RS40	Adjustable for all ports (default setting: port 1.4)
MICE	Adjustable for all ports (default setting: port 1.4)
PowerMICE	Adjustable for all ports (default setting: port 1.4)
MS 20	Adjustable for all ports (default setting: port 1.4)
MS 30	Adjustable for all ports (default setting: port 2.4)
RSR20/30	Adjustable for all ports (default setting: port 1.4)
MACH 1000	Adjustable for all ports (default setting: port 1.4)
MACH 3000	Adjustable for all ports
MACH 4000	Adjustable for all ports (default setting: port 1.4)

Table 9: Port assignment for the redundant coupling

Note: Configure the coupling port and the HIPER-Ring ports on different ports.

☐ Activate the function in the “Operation” frame (see fig. 15).
☐ You now connect the redundant line.

The displays in the “Select port” frame mean (see fig. 15):
– “Port mode”: The port is either active or in stand-by mode.
– “Port state”: The port is either connected or not connected.
– “IP Address”: The IP address of the partner, if the partner is already operating in the network.

The displays in the “Information” frame mean (see fig. 15):
– “Redundancy guaranteed”: One of the lines affected can fail, as a redundant line will then take over the function of the failed line.
– “Configuration failure”: The function is incomplete or incorrectly configured.

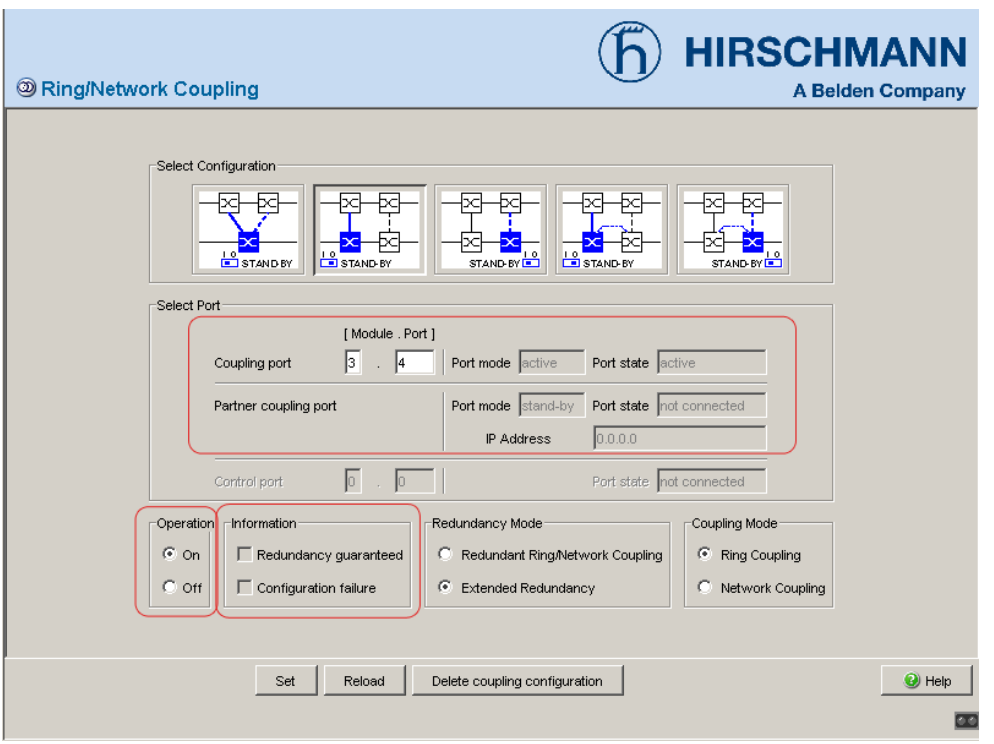


Figure 15: Selecting the port and enabling/disabling operation

To avoid continuous loops, the Switch sets the port state of the coupling port to “off” if you:
– switch off operation or
– change the configuration
while the connections are in operation at these ports.

Note: The following settings are required for the coupling ports (you select the `Basic Settings:Port Configuration` dialog):
– Port: on
– Automatic configuration (autonegotiation): on for twisted-pair connections
– Manual configuration: 100 Mbit/s FDX for glass fiber connections

Note: If VLANS are configured, note the VLAN configuration of the coupling and partner coupling ports.
In the Network/Ring Coupling configuration, select for the coupling and partner coupling ports
– VLAN ID 1 and “Ingress Filtering” disabled in the port table and
– VLAN membership `U` in the static VLAN table.

Note: Operating the redundancy manager and two-Switch coupling functions at the same time runs the risk of creating a loop.

☐ Select two-Switch redundant coupling (see fig. 16).

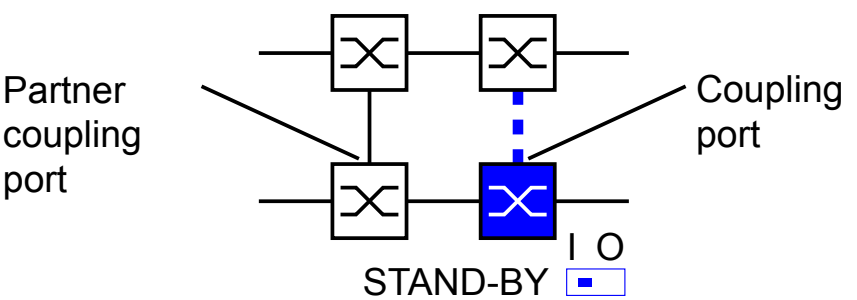


Figure 16: Two-Switch coupling

The following settings apply to the Switch displayed in blue in the selected graphic.

☐ Select the coupling port (see fig. 15), (see table 9).
With “Coupling port” you specify at which port you are connecting the network segments.

☐ If the STANDBY DIP switch is ON, connect the main line to the coupling port.

Note: Configure the coupling port and the HIPER-Ring ports on different ports.

☐ Activate the function in the “Operation” frame (see fig. 15).

The displays in the “Select port” frame mean (see fig. 15):

– “Port mode”: The port is either active or in stand-by mode.
– “Port state”: The port is either connected or not connected.
– “IP Address”: The IP address of the partner, if the partner is already operating in the network.

The displays in the “Information” frame mean (see fig. 15):

– “Redundancy guaranteed”: One of the lines affected can fail, as a redundant line will then take over the function of the failed line.
– “Configuration failure”: The function is incomplete or incorrectly configured.

To avoid continuous loops, the Switch sets the port state of the coupling port to “off” if you:

– switch off operation or
– change the configuration

while the connections are in operation at these ports.

Note: The following settings are required for the coupling ports (you select the `Basic Settings:Port Configuration` dialog):

– Port: on
– Automatic configuration (autonegotiation):
  on for twisted-pair connections
– Manual configuration: 100 Mbit/s FDX
  for glass fiber connections

Note: If VLANS are configured, note the VLAN configuration of the coupling and partner coupling ports.
In the Network/Ring Coupling configuration, select for the coupling and partner coupling ports

– VLAN ID 1 and “Ingress Filtering” disabled in the port table and
– VLAN membership `U` in the static VLAN table.

Note: Operating the redundancy manager and two-Switch coupling functions at the same time runs the risk of creating a loop.

Redundancy mode

☐ In the “Redundancy Mode” frame, select (see fig. 17)

– “Redundant Ring/Network Coupling” or
– “Extended Redundancy”.

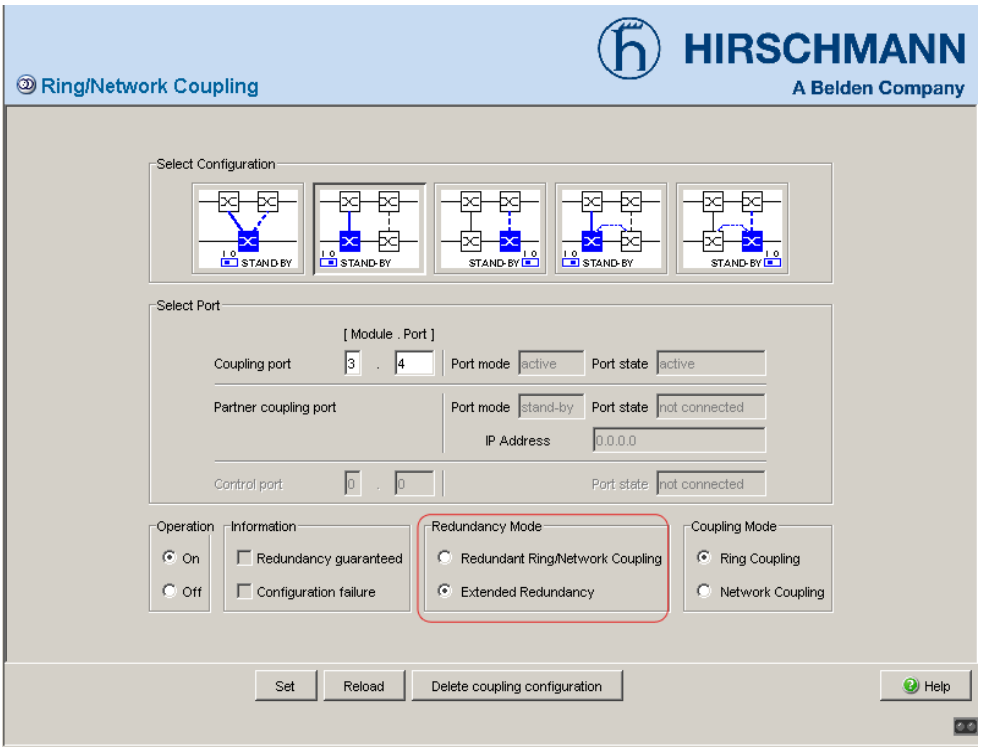


Figure 17: Selecting the redundancy mode

With the “Redundant Ring/Network Coupling” setting, either the main line or the redundant line is active. Both lines are never active simultaneously.

With the “Extended Redundancy” setting, the main line and the redundant line are simultaneously active if the connection line between the Switches in the connected network fails (see fig. 18).
During the reconfiguration period, there may be package duplications. Therefore, only select this setting if your application detects package duplications.

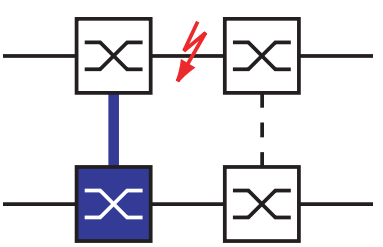


Figure 18: Extended redundancy

Coupling mode

The coupling mode indicates the type of the connected network.

☐ In the “Coupling Mode” frame, select (see fig. 19)

– “Ring Coupling” or

– “Network Coupling”

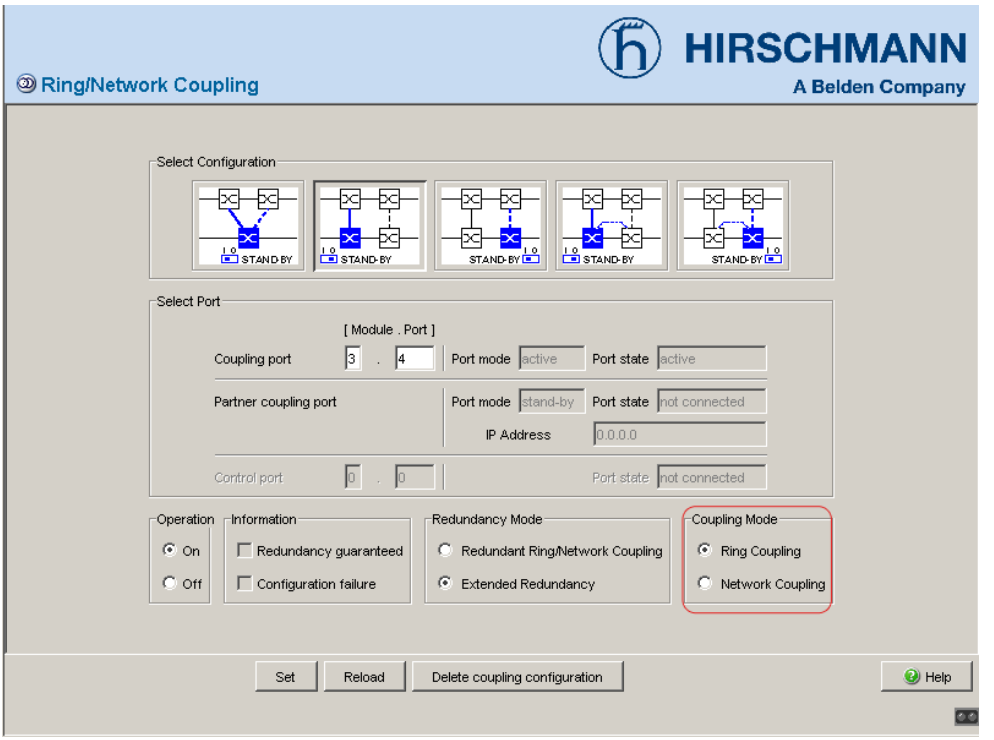


Figure 19: Selecting the coupling mode

☐ Select **“Ring coupling”** if you are connecting a HIPER-Ring.

☐ Select **“Network Coupling”** if you are connecting a line structure.

Delete coupling configuration

☐ The “Delete coupling configuration” button in the dialog allows you to reset all the coupling settings of the device to the state on delivery.

3.2.4 Two-Switch coupling with control line

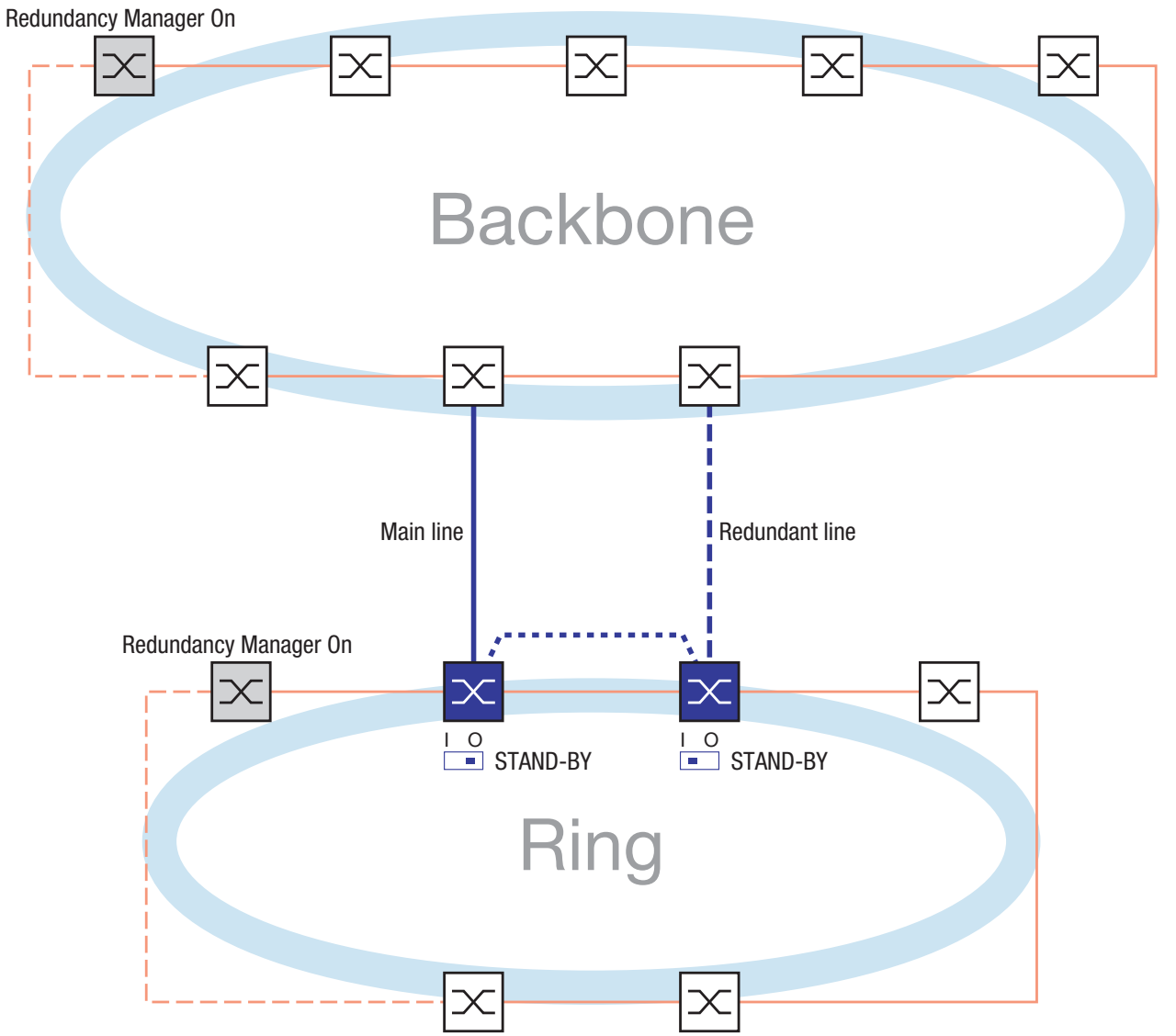


Figure 20: Example of Two-Switch coupling with control line

The coupling between two networks is effected by the main line (thick blue line). If the main line fails, the redundant line (thick blue dotted line) takes over coupling the two networks.
The coupling is effected by two Switches.
The Switches send their control packets via a control line.
The Switch to which you connect the main line, and the Switch to which you connect the redundant line, are partners as regards the coupling.

☐ Connect the two partners via their ring ports.

☐ Select the `Redundancy:Ring/Network Coupling` dialog.

☐ Select two-Switch main coupling with control line (see fig. 21).

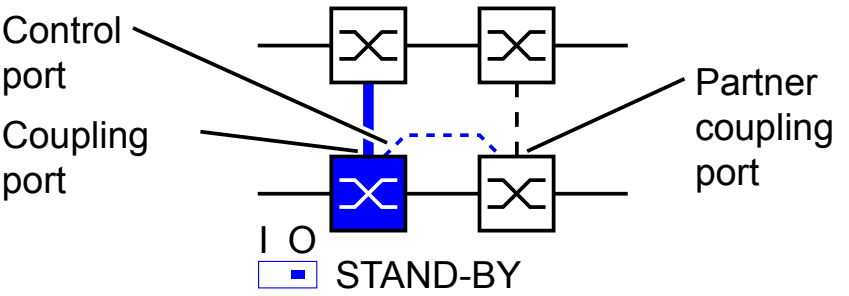


Figure 21: Two-Switch coupling with control line

The following settings apply to the Switch displayed in blue in the selected graphic.

☐ Select the coupling port (see fig. 22), (see table 10).
With “Coupling port” you specify at which port you are connecting the redundant line.

☐ If the STANDBY DIP switch is OFF, connect the main line to the coupling port.

☐ Select the control port (see fig. 22), (see table 10).
With “Control port” you specify at which port you are connecting the control line.

Switch	Coupling port	Control port
RS2-../..	Port 1	Stand-by port (can only be combined with RS2-../..)
RS2-16M	Adjustable for all ports (default setting: port 1)	Adjustable for all ports (default setting: port 2)
RS20	Adjustable for all ports (default setting: port 1.4)	Adjustable for all ports (default setting: port 1.3)
RS30	Adjustable for all ports (default setting: port 1.4)	Adjustable for all ports (default setting: port 1.3)
RS40	Adjustable for all ports (default setting: port 1.4)	Adjustable for all ports (default setting: port 1.3)
MICE	Adjustable for all ports (default setting: port 1.4)	Adjustable for all ports (default setting: port 1.3)
PowerMICE	Adjustable for all ports (default setting: port 1.4)	Adjustable for all ports (default setting: port 1.3)
MS 20	Adjustable for all ports (default setting: port 1.4)	Adjustable for all ports (default setting: port 1.3)
MS 30	Adjustable for all ports (default setting: port 2.4)	Adjustable for all ports (default setting: port 2.3)
RSR20/RSR30	Adjustable for all ports (default setting: port 1.4)	Adjustable for all ports (default setting: port 1.3)
MACH 1000	Adjustable for all ports (default setting: port 1.4)	Adjustable for all ports (default setting: port 1.3)
MACH 3000	Adjustable for all ports	Adjustable for all ports
MACH 4000	Adjustable for all ports (default setting: port 1.4)	Adjustable for all ports (default setting: port 1.3)

Table 10: Port assignment for the redundant coupling

Note: Configure the coupling port and the HIPER-Ring ports on different ports.

☐ Activate the function in the “Operation” frame (see fig. 22).

☐ You now connect the redundant line and the control line.

The displays in the “Select port” frame mean (see fig. 22):

– “Port mode”: The port is either active or in stand-by mode.
– “Port state”: The port is either connected or not connected.
– “IP Address”: The IP address of the partner, if the partner is already operating in the network.

The displays in the “Information” frame mean (see fig. 22):

– “Redundancy guaranteed”: One of the lines affected can fail, as a redundant line will then take over the function of the failed line.
– “Configuration failure”: The function is incomplete or incorrectly configured.

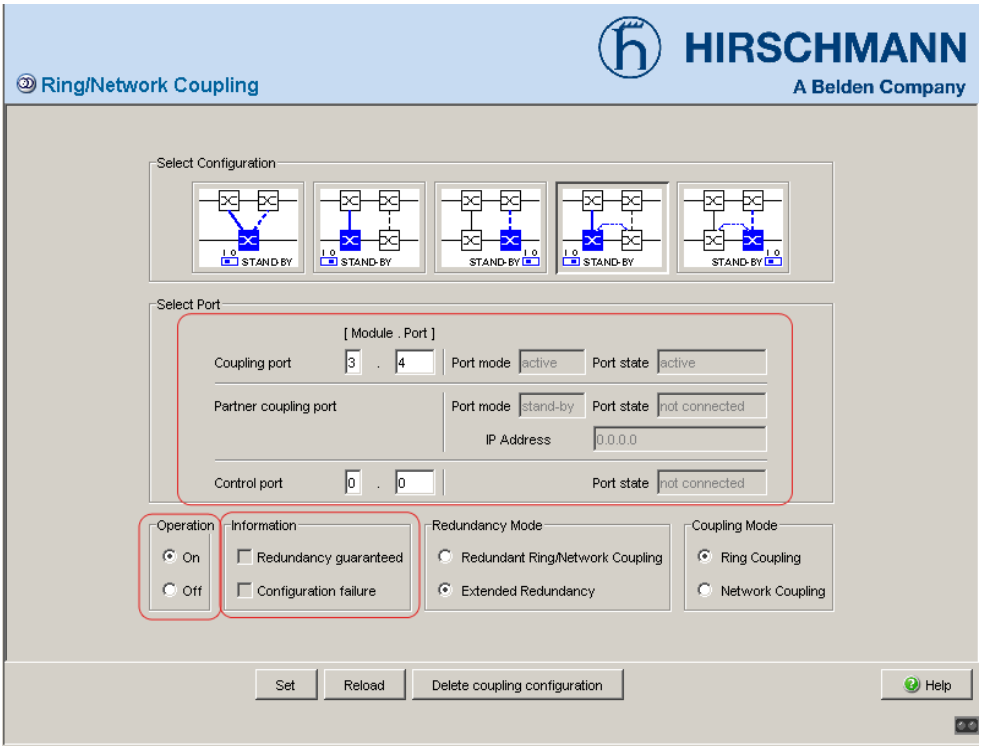


Figure 22: Selecting the port and enabling/disabling operation

To avoid continuous loops, the Switch sets the port state of the coupling port to “off” if you:

– switch off operation or
– change the configuration

while the connections are in operation at these ports.

Note: The following settings are required for the coupling ports (you select the `Basic Settings:Port Configuration` dialog):

– Port: on
– Automatic configuration (autonegotiation): on for twisted-pair connections
– Manual configuration: 100 Mbit/s FDX for glass fiber connections

Note: If VLANS are configured, note the VLAN configuration of the coupling and partner coupling ports.
In the Network/Ring Coupling configuration, select for the coupling and partner coupling ports
– VLAN ID 1 and “Ingress Filtering” disabled in the port table and
– VLAN membership `U` in the static VLAN table.

☐ Select two-Switch redundant coupling with control line (see fig. 23).

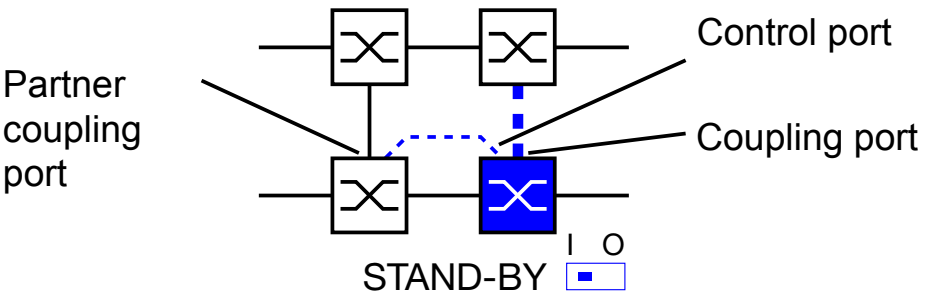


Figure 23: Two-Switch coupling with control line

The following settings apply to the Switch displayed in blue in the selected graphic.

☐ Select the coupling port (see fig. 22), (see table 10).
With “Coupling port” you specify at which port you are connecting the network segments.

☐ If the STANDBY DIP switch is ON, connect the main line to the coupling port.

☐ Select the control port (see fig. 22), (see table 10).
With “Control port” you specify at which port you are connecting the control line.

Note: Configure the coupling port and the HIPER-Ring ports on different ports.

☐ Activate the function in the “Operation” frame (see fig. 22).

☐ You now connect the redundant line and the control line.

The displays in the “Select port” frame mean (see fig. 22):
– “Port mode”: The port is either active or in stand-by mode.
– “Port state”: The port is either connected or not connected.
– “IP Address”: The IP address of the partner, if the partner is already operating in the network.

The displays in the “Information” frame mean (see fig. 22):
– “Redundancy guaranteed”: One of the lines affected can fail, as a redundant line will then take over the function of the failed line.
– “Configuration failure”: The function is incomplete or incorrectly configured.

To avoid continuous loops, the Switch sets the port state of the coupling port to “off” if you:
– switch off operation or
– change the configuration

while the connections are in operation at these ports.

Note: The following settings are required for the coupling ports (you select the `Basic Settings:Port Configuration` dialog):
– Port: on
– Automatic configuration (autonegotiation): on for twisted-pair connections
– Manual configuration: 100 Mbit/s FDX for glass fiber connections

Note: If VLANS are configured, note the VLAN configuration of the coupling and partner coupling ports.
In the Network/Ring Coupling configuration, select for the coupling and partner coupling ports
– VLAN ID 1 and “Ingress Filtering” disabled in the port table and
– VLAN membership `U` in the static VLAN table.

Redundancy mode

☐ In the “Redundancy Mode” frame, select (see fig. 24)
– “Redundant Ring/Network Coupling” or
– “Extended Redundancy”.

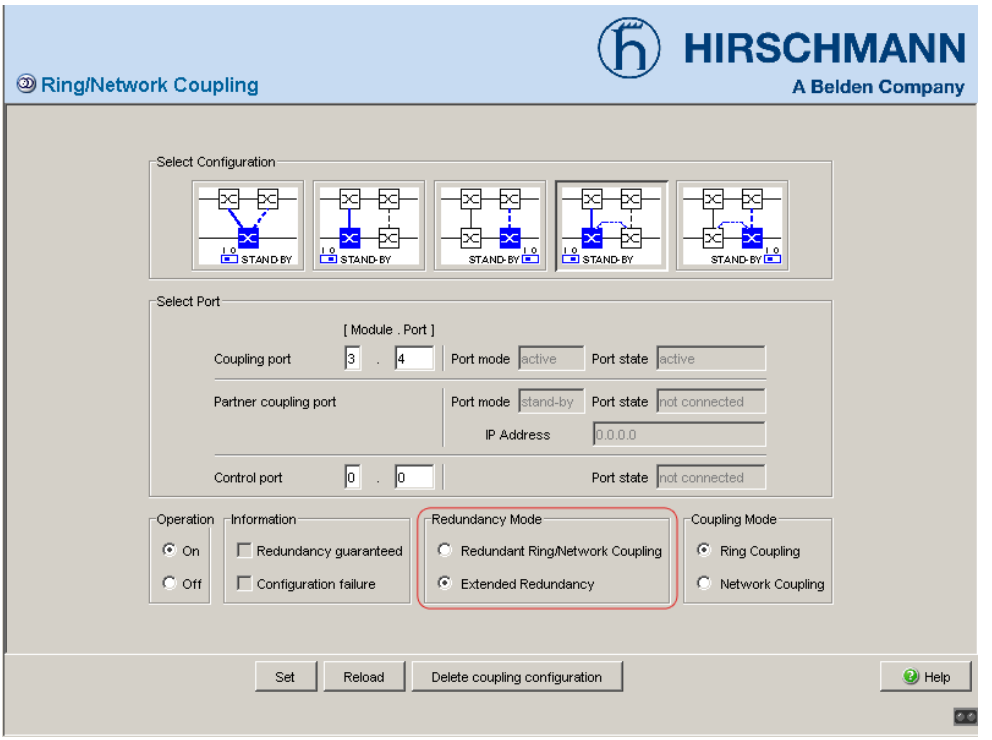


Figure 24: Selecting the redundancy mode

With the “Redundant Ring/Network Coupling” setting, either the main line or the redundant line is active. Both lines are never active simultaneously.

With the “Extended Redundancy” setting, the main line and the redundant line are simultaneously active if the connection line between the Switches in the connected network fails (see fig. 25).

During the reconfiguration period, there may be package duplications. Therefore, only select this setting if your application detects package duplications.

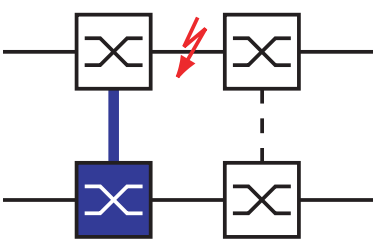


Figure 25: Extended redundancy

Coupling mode

The coupling mode indicates the type of the connected network.

☐ In the “Coupling Mode” frame, select (see fig. 26)

– “Ring Coupling” or

– “Network Coupling”

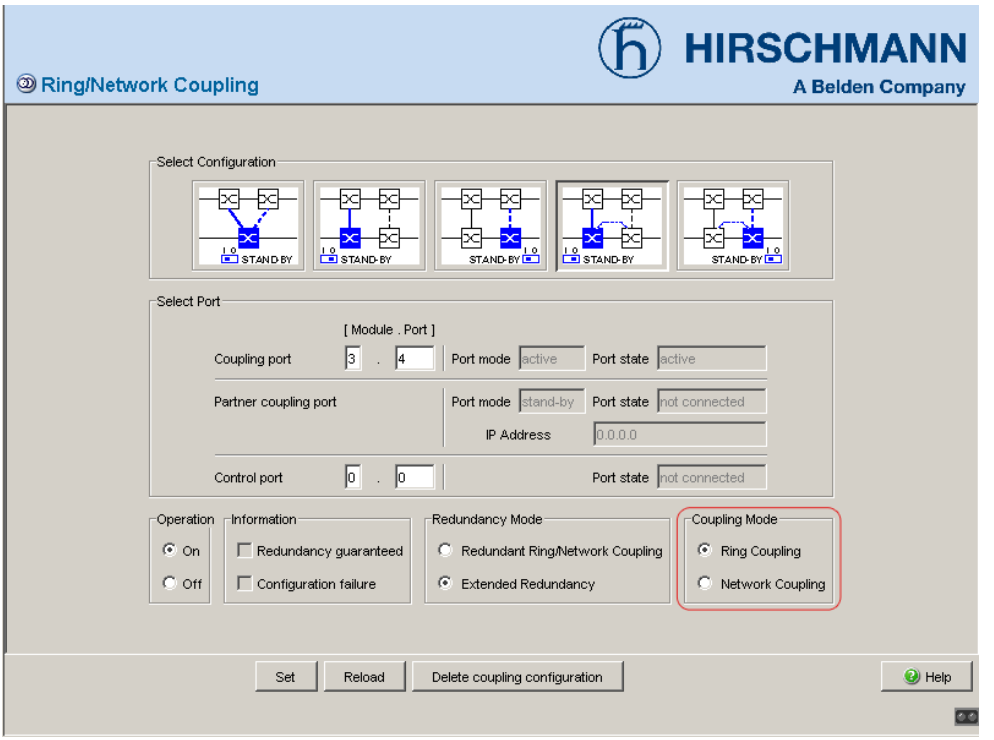


Figure 26: Selecting the coupling mode

☐ Select **“Ring coupling”** if you are connecting a HIPER-Ring.

☐ Select **“Network Coupling”** if you are connecting a line structure.

Delete coupling configuration

☐ The “Delete coupling configuration” button in the dialog allows you to reset all the coupling settings of the device to the state on delivery.

4 Rapid Spanning Tree

Note: The Spanning Tree protocol and the Rapid Spanning Tree protocol are protocols for MAC bridges. They are described in the standards IEEE 802.1D-2004 and IEEE 802.1w. For this reason, the following description of these protocols usually employs the term bridge instead of switch.

Local networks are getting bigger and bigger. This applies to both the geographical expansion and the number of network participants. Therefore, it often makes sense to use multiple bridges, for example:

- to reduce the network load in subareas,
- to set up redundant connections and
- to overcome distance limitations.

However, using multiple bridges with multiple redundant connections between the subnetworks can lead to loops and thus the total failure of the network. To prevent this, the (Rapid) Spanning Tree Algorithm was developed. The Rapid Spanning Tree Protocol (RSTP) enables redundancy by interrupting loops.

RSTP is a further development of the Spanning Tree Protocol (STP) and is compatible with it. If a connection or a bridge fails, the STP requires up to 30 seconds to reconfigure. This was no longer acceptable in time-sensitive applications. The STP was therefore developed into the RSTP, leading to reconfiguration times of less than a second.

Note: Standards dictate that all the bridges within a network work with the (Rapid) Spanning Tree Algorithm. However, if STP and RSTP are used at the same time, the advantages of faster reconfiguration with RSTP are lost.

4.1 The Spanning Tree Protocol

Because RSTP is a further development of the STP, all the following descriptions of the STP also apply to the RSTP.

4.1.1 The tasks of the STP

The Spanning Tree Algorithm reduces network topologies that are set up using bridges, and that have ring structures with redundant connections, to a tree structure. In doing this, STP divides up the ring structures on the basis of specified rules by deactivating redundant paths. If a path is interrupted by mistake, the STP reactivates the path just deactivated. This enables redundant connections for increased data safety.
In forming the tree structure, the STP determines what is known as a root bridge. This forms the basis of the STP tree structure.

Features of the STP algorithm:

- automatic reconfiguration of the tree structure in the case of a bridge error or the interruption of a data path
- the tree structure is stabilized up to the maximum network size (up to 39 hops, depending on the setting for "Max. Age")
- stabilization is effected within a brief, specified period
- topology can be specified and reproduced by the management
- transparency for the terminal devices
- low network load relative to the available transmission capacity due to the tree structure created

4.1.2 Bridge parameters

Each bridge is uniquely described using parameters:

- Bridge Identifier
- Root Path Costs for the bridge ports
- Port Identifier

4.1.3 Bridge Identifier

The Bridge Identifier consists of 8 bytes. The two highest-value bytes are the priority number. The default setting for the priority number is 32 768, but the Management Administrator can change this when configuring the network.
The six lowest-value bytes of the bridge identifier are the MAC address of the bridge. The MAC address guarantees that every bridge has a different bridge identifier.
The bridge with the smallest number for the bridge identifier has the highest priority.

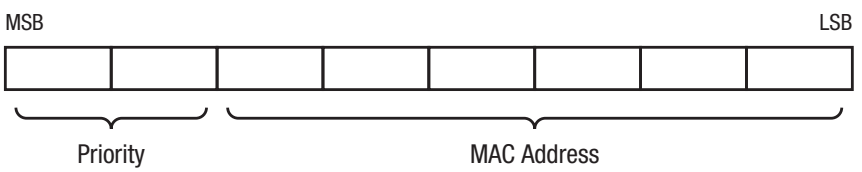


Figure 27: Bridge Identifier

4.1.4 Root Path Costs

Every path that connects two bridges is assigned costs for the transmission (path costs). The Switch specifies this value based on the transmission speed (see table 11). It assigns the higher path costs to paths with lower transmission speeds.

Alternatively, the Management Administrator can specify the path costs. Like the Switch, the Administrator assigns the higher path costs to paths with lower transmission speeds. However, since the Administrator can choose this value freely, he has a tool with which he can give a certain path an advantage among redundant paths.

The root path costs are the sum of all the individual path costs for all paths along which a data packet travels between the connected port of a bridge and the root bridge.

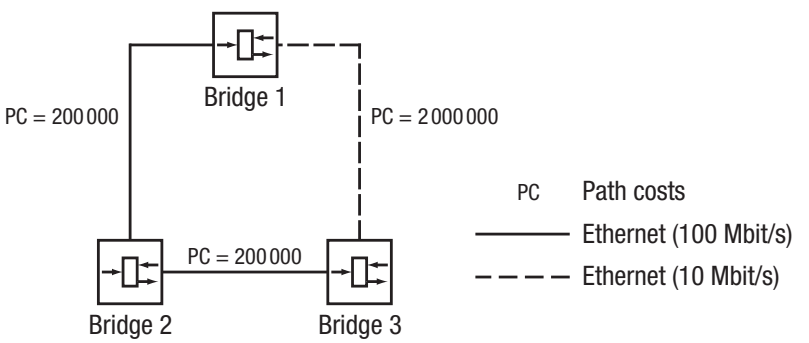


Figure 28: Path costs

Data rate	Recommended value	Recommended range	Possible range
<=100 KBit/s	200 000 000*	20 000 000-200 000 000	1-200 000 000
1 MBit/s	20 000 000*	2 000 000-200 000 000	1-200 000 000
10 MBit/s	2 000 000*	200 000-20 000 000	1-200 000 000
100 MBit/s	200 000*	20 000-2 000 000	1-200 000 000
1 GBit/s	20 000	2 000-200 000	1-200 000 000
10 GBit/s	2 000	200-20 000	1-200 000 000
100 GBit/s	200	20-2 000	1-200 000 000
1 TBit/s	20	2-200	1-200 000 000
10 TBit/s	2	1-20	1-200 000 000

Table 11: Recommended path costs for RSTP based on the data rate
** Bridges that conform with IEEE 802.1D, 1998 edition, and only support 16-bit values for the path costs should use the value 65 535 for path costs when they are used in conjunction with bridges that support 32-bit values for the path costs.*

4.1.5 Port Identifier

The Port Identifier consists of 2 bytes. One part, the lowest-value byte, signifies the fixed relationship with the physical port number. This part ensures that no port of a bridge has the same identifier as another port of this bridge. The second part is the port priority number, which is specified by the Management Administrator (default value: 128). It also applies here that the port with the smallest number for the port identifier has the highest priority.

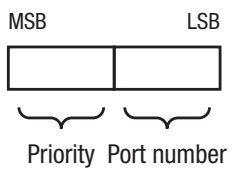


Figure 29: Port Identifier

4.2 Rules for creating the tree structure

4.2.1 Bridge information

To calculate the tree structure, the bridges require more detailed information about the other bridges located in the network.
To obtain this information, each bridge sends a BPDU (Bridge Protocol Data Unit) to the other bridges.

The contents of a BPDU include

- bridge identifier,
- root path costs and
- port identifier

(see IEEE 802.1D).

4.2.2 Setting up the tree structure

- The bridge with the smallest number for the bridge identifier is the root bridge. It is the root of the tree structure.
- The structure of the tree depends on the root path costs. STP selects the structure so that the path costs between each individual bridge and the root bridge are kept to a minimum.
- In the case of a number of paths with the same root path costs, the priority of the bridge identifier for the bridge connected to one of these paths decides which bridge should block.

- If two paths with the same root path costs lead out from a bridge, the port identifier is used as the last criterion (see fig. 29). This decides which port is selected.

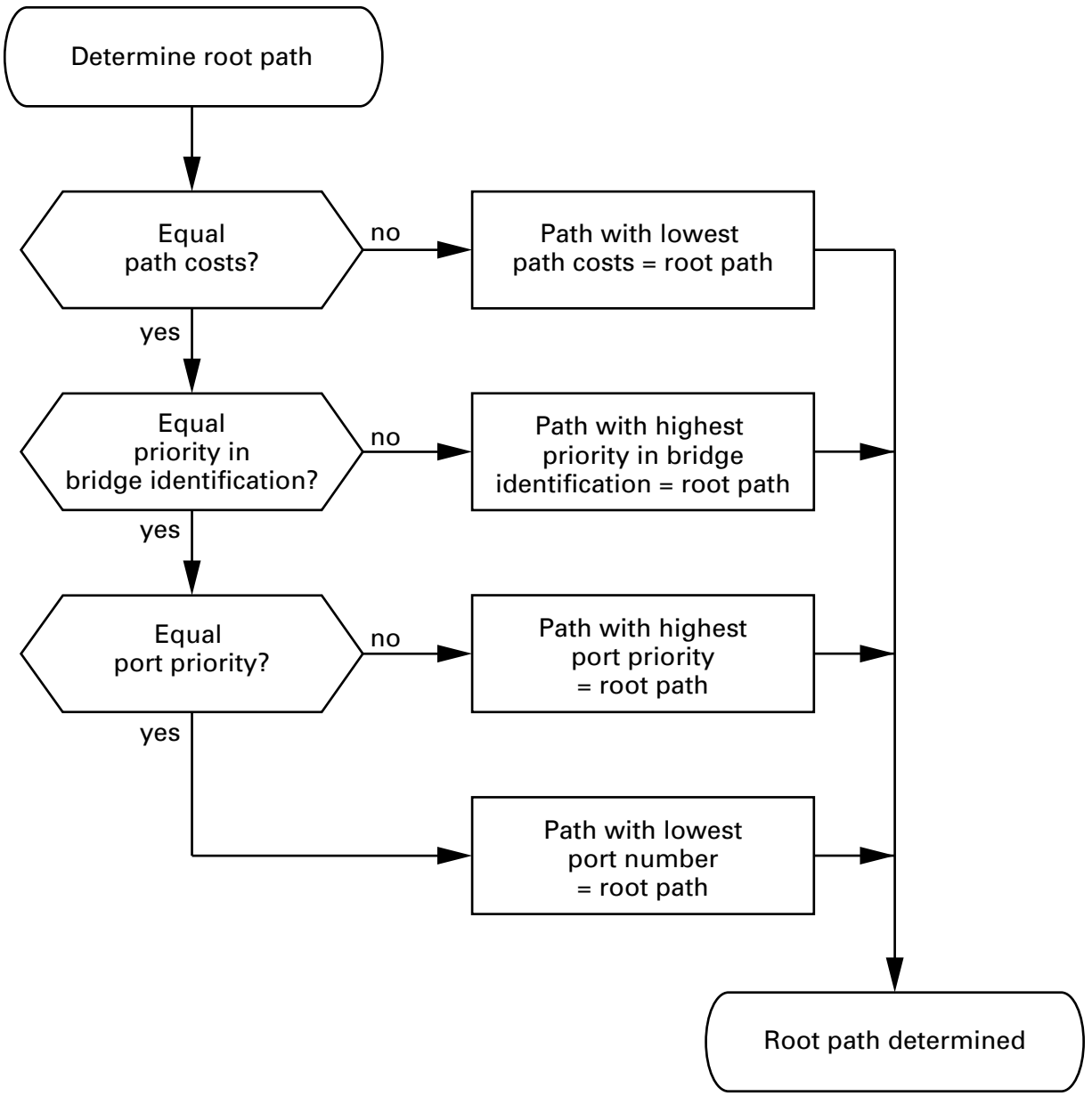


Figure 30: Flow diagram for specifying the root path

4.3 Example of specifying the root paths

The network plan (see fig. 31) can be used to create the flow diagram (see fig. 30) for defining the root path. The Administrator defined a different priority in the bridge identifier for each bridge. The bridge with the smallest number for the bridge identifier is the root bridge, in this case bridge 1. In the example, all the sub-paths have the same path costs. The path between bridge 2 and bridge 3 is interrupted, because a connection from bridge 3 to the root bridge via bridge 2 would double the path costs.

The path from bridge 6 to the root bridge is interesting:

- The path via bridge 5 and bridge 3 creates the same root path costs as the path via bridge 4 and bridge 2.
- The path via bridge 4 is selected because value 28 672 for the priority in the bridge identifier is smaller than value 32 768.
- However, there are two paths between bridge 6 and bridge 4. The port identifier is decisive here.

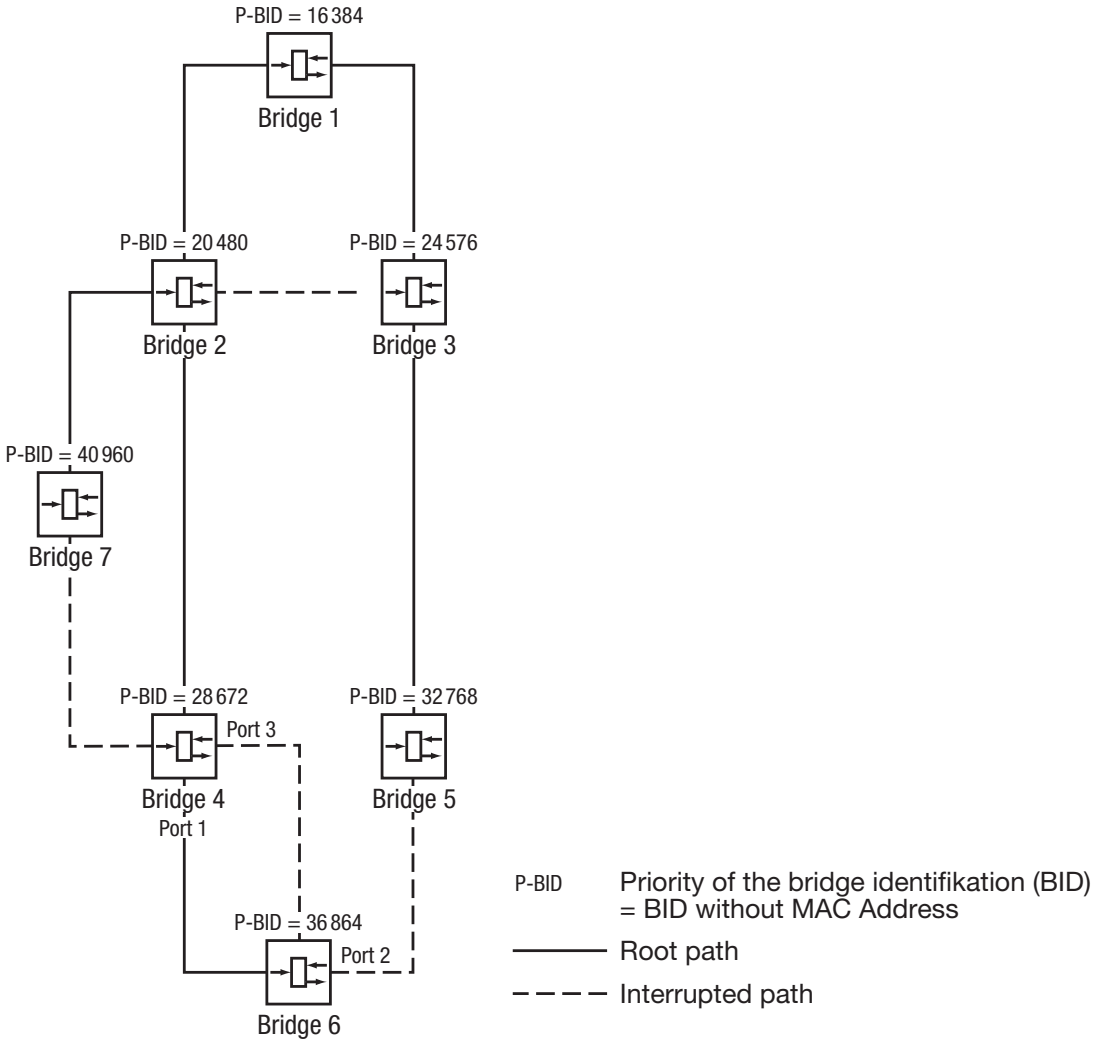


Figure 31: Example of specifying the root path

4.4 Example of manipulating the root paths

The network plan (see fig. 32) can be used to create the flow diagram (see fig. 30) for defining the root path. The Administrator
– left the default value of 32 768 for each bridge apart from bridge 1, and
– gave bridge 1 the value 16 384, thus making it the root bridge.
In the example, all the sub-paths have the same path costs. The path between bridge 2 and bridge 3 is interrupted, because a connection from bridge 3 to the root bridge via bridge 2 would double the path costs.

The path from bridge 6 to the root bridge is interesting:

- The path via bridge 5 and bridge 3 creates the same root path costs as the path via bridge 4 and bridge 2.
- STP selects the path using the bridge that has the lowest MAC address in the bridge identification (bridge 4 in the illustration).
- However, there are two paths between bridge 6 and bridge 4. The port identifier is decisive here.

Note: Because the Administrator does not change the default values for the priorities of the bridges in the bridge identifier, apart from the value for the root bridge, the MAC address in the bridge identifier alone determines which bridge becomes the new root bridge if the root bridge goes down.

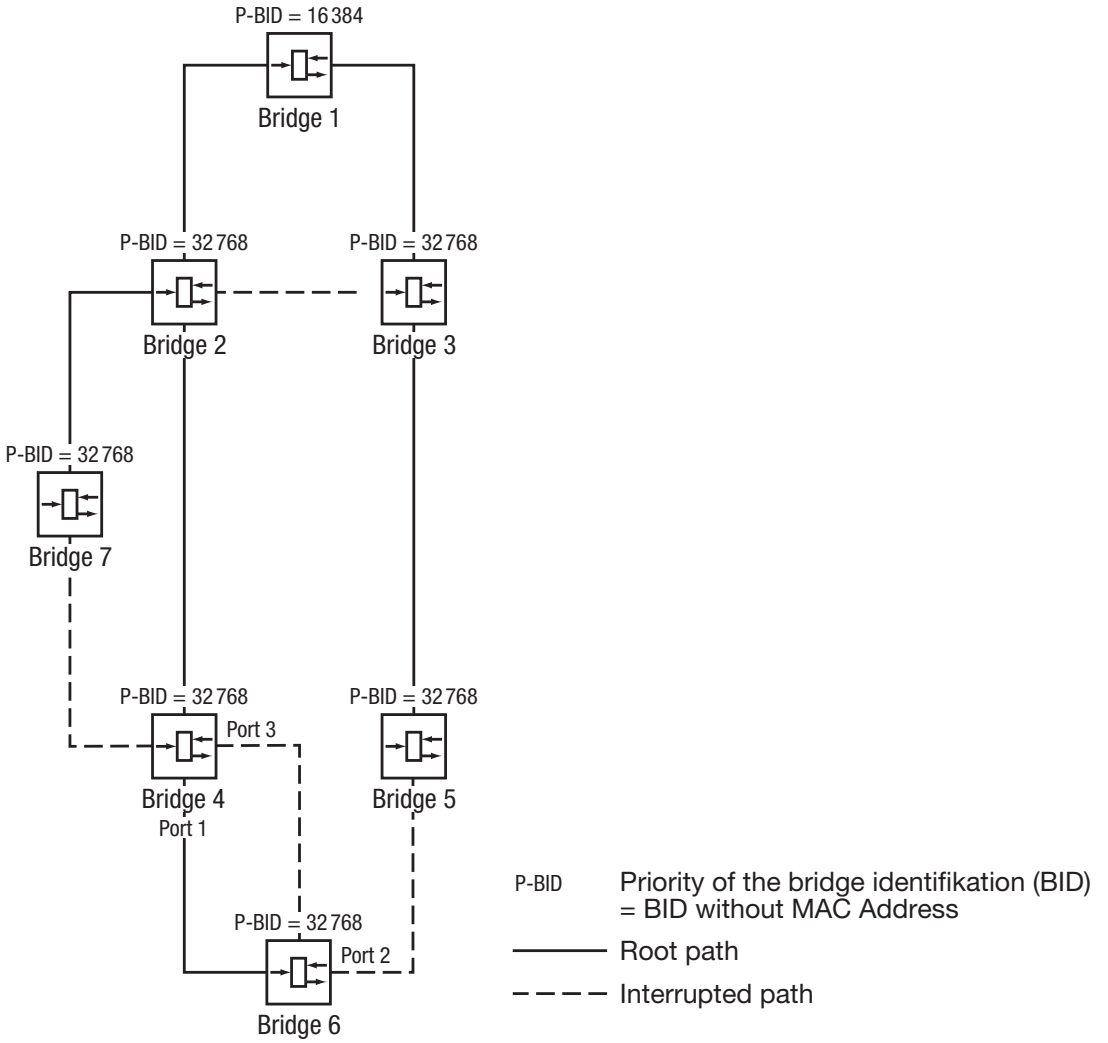


Figure 32: Example of manipulating the root path

4.5 Example of manipulating the tree structure

The Management Administrator soon discovers that this configuration with bridge 1 as the root bridge (see on page 56 „Example of specifying the root paths“) is unfavorable. On the paths from bridge 1 to bridge 2 and bridge 1 to bridge 3, the control packets which the root bridge sends to all other bridges are adding up.
If the Management Administrator makes bridge 2 the root bridge, the burden of the control packets on the subnetworks is distributed much more evenly. The result is the configuration shown here (see fig. 33). The distances between the individual bridges and the root bridge are now shorter.

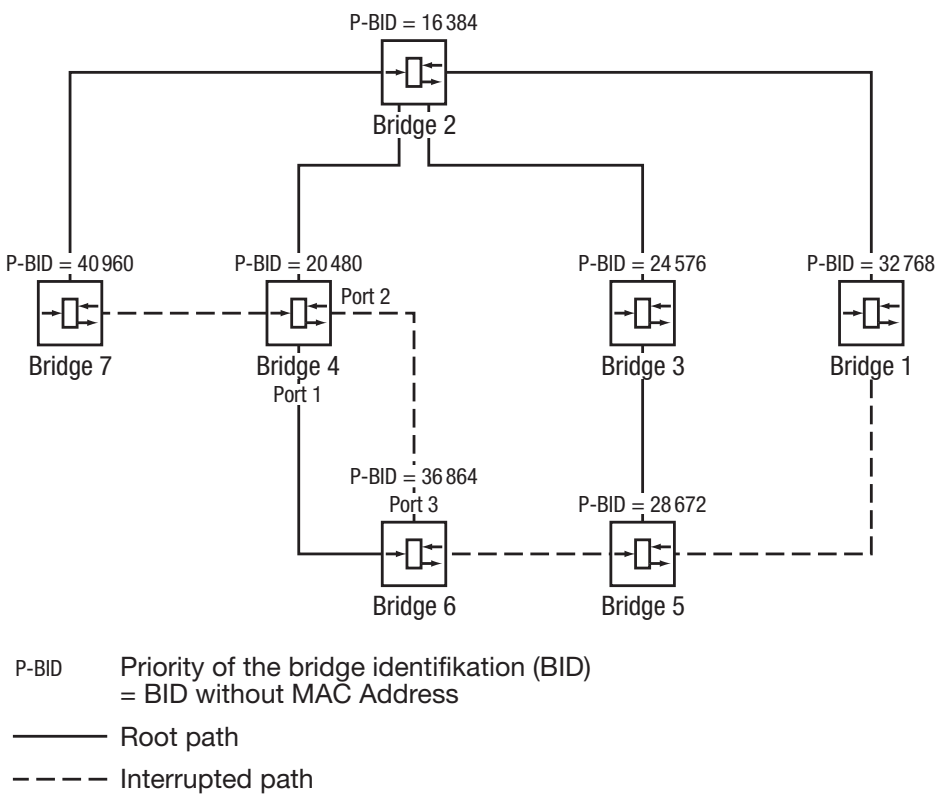


Figure 33: Example of manipulating the tree structure

4.6 The Rapid Spanning Tree Protocol

The RSTP takes over the calculation of the tree structure by the STP unchanged. RSTP merely changes parameters, and adds new parameters and mechanism that speed up the reconfiguration in the case of a failure.
The ports play a significant role in this context.

4.6.1 Port roles

RSTP assigns each bridge port one of the following roles (see fig. 34):

- Root port
  This is the port at which a bridge receives data packets with the lowest path costs from the root bridge.
  If there are multiple ports with the same low path costs, the bridge identifier determines which port is the root port.
  If there are multiple ports with the same low path costs and the same bridge identifier, the port identifier determines which port is the root port (see fig. 30).
  The root bridge does not have a root port.
- Designated port
  The bridge in a network segment that has the lowest root path costs is the designated bridge. If multiple bridges have the same root path costs, then the bridge with the smallest value for the bridge identifier becomes the designated bridge. The port on this bridge that connects it to a network segment that leads from the root bridge, is the designated port.
- Edge port
  Every network segment in which there are no additional RSTP bridges is connected with exactly one designated port. This designated port is then also an edge port. The distinction of an edge port is the fact that it does not receive any RST BPDUs (Rapid Spanning Tree Bridge Protocol Data Unit).

- Alternate port
  This is a blocked port that takes over the task of the bridge port if the connection to the root bridge fails. The alternate port guarantees the connection of the bridge to the root bridge.
- Backup port
  This is a blocked port that serves as a backup in case the connection to the designated port of this network segment (without RSTP bridge) fails.
- Disabled port
  This is the port that does not play any role with the Spanning Tree Operation, and is therefore switched off or does not have any connection.

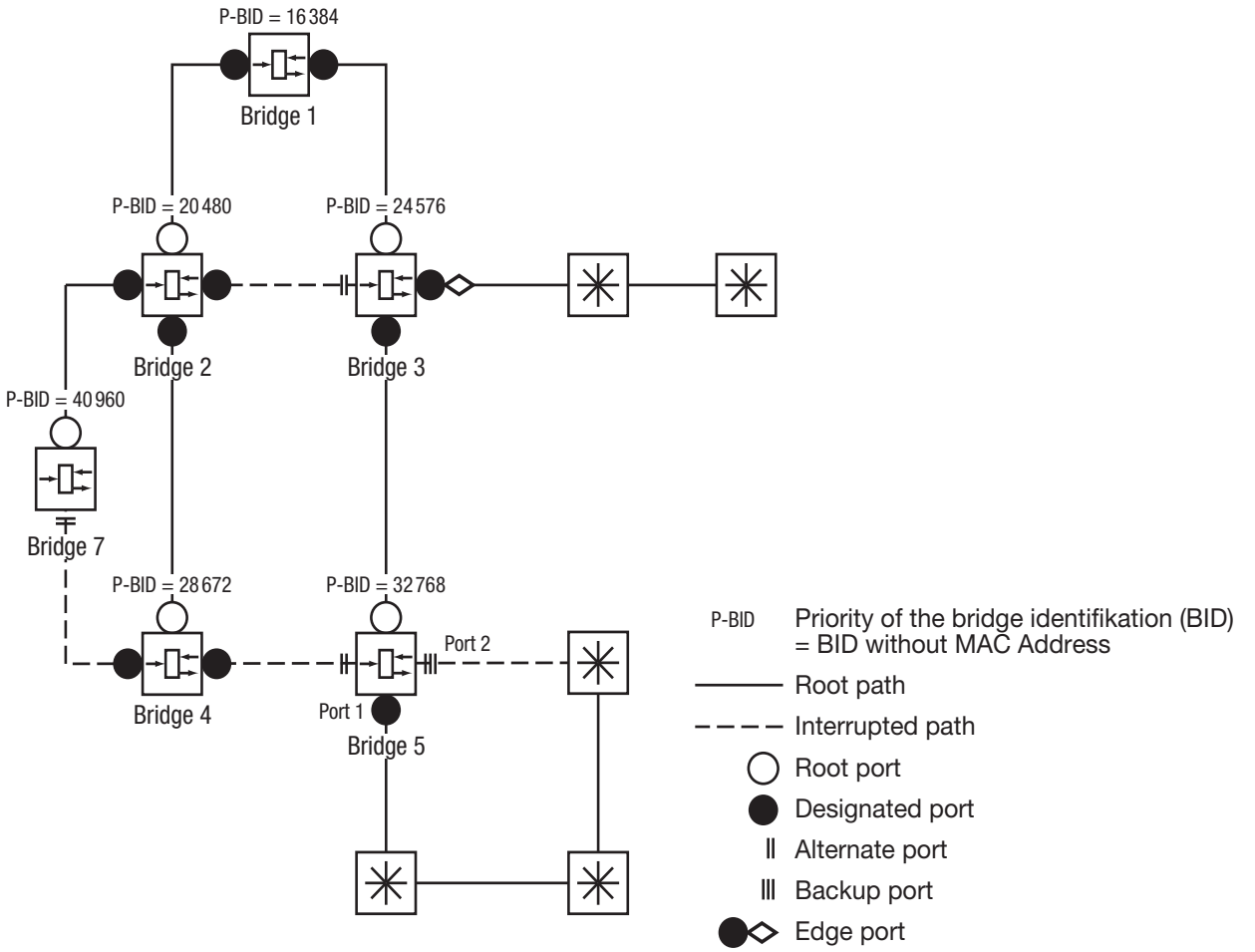


Figure 34: Port role assignment

4.6.2 Port states

Depending on the tree structure and the state of the selected connection paths, the RSTP assigns the ports their states.

STP port state	Administrative bridge port state	MAC operational	RSTP Port state	Active topology (Port role)
DISABLED	Disabled	FALSE	Discarding*	Excluded (disabled)
DISABLED	Enabled	FALSE	Discarding*	Excluded (disabled)
BLOCKING	Enabled	TRUE	Discarding**	Excluded (alternate, backup)
LISTENING	Enabled	TRUE	Discarding**	Included (root, designated)
LEARNING	Enabled	TRUE	Learning	Included (root, designated)
FORWARDING	Enabled	TRUE	Forwarding	Included (root, designated)

Table 12: Relationship between port state values in STP and RSTP.
** the dot1d MIB shows “Disabled”*
*** the dot1d MIB shows “Blocked”*

Meaning of the RSTP port states:

- Disabled = port does not belong to the active topology
- Discarding = no address learning in FDB and no data traffic apart from sending and receiving
- Learning = address learning active (FDB) and no data traffic apart from BPDUs
- Forwarding = address learning active (FDB) and sending and receiving active from all frames (not only BPDUs)

4.6.3 Spanning Tree Priority Vector

To assign roles to the ports, the RSTP bridges exchange configuration information with each other. This information is known as the Spanning Tree Priority Vector. It is part of the RST BPDUs and contains the following information:

- Bridge identifier of the root bridges
- Root path costs for the sending bridges
- Bridge identifier for the sending bridges
- Port identifiers of the ports through which the message was sent
- Port identifiers of the ports through which the message was received

Based on this information, the bridges participating in RSTP are able to calculate port roles themselves and define the port states of their own ports.

4.6.4 Fast reconfiguration

Why can RSTP react faster than STP to an interruption of the root path?

- Introduction of edge ports
  During a reconfiguration, RSTP switches an edge port into the transmission mode after three seconds and then waits for the “Hello Time” (see table 13) to elapse, to be sure that no bridge sending BPDUs is connected.
  When the user is sure that a terminal device is connected at this port and will remain connected, he can switch off RSTP at this port. Thus no waiting times occur at this port in the case of a reconfiguration.
- Introduction of alternate ports
  As the port roles are already distributed in normal operation, a bridge can immediately switch from the root port to the alternate port after the connection to the root bridge is lost.
- Communication with neighboring bridges (point-to-point connections)
  Decentralized, direct communication between neighboring bridges enables immediate reaction to status changes in the spanning tree architecture.
- Filter table
  With STP, the age of the entries in the filter table determines the updating. RSTP immediately deletes the entries in those ports affected by a reconfiguration.
- Reaction to events
  Without having to adhere to any time specifications, RSTP immediately reacts to events such as connection interruptions, connection reinstatements, etc.

Note: The price to be paid for this fast reconfiguration is the risk that data packets may be duplicated or mixed up during the reconfiguration phase. If this is unacceptable for your application, switch to the slower Spanning Tree Protocol or select one of the other, faster redundancy procedures described in this manual.

4.6.5 Configuring the Rapid Spanning Tree

☐ Set up the network to meet your requirements.

Note: Before you connect the redundant lines, you must complete the configuration of the RSTP.
You thus avoid loops during the configuration phase.

☐ Select the `Redundancy:Rapid Spanning Tree:Global` dialog.
☐ Switch on RSTP on every device

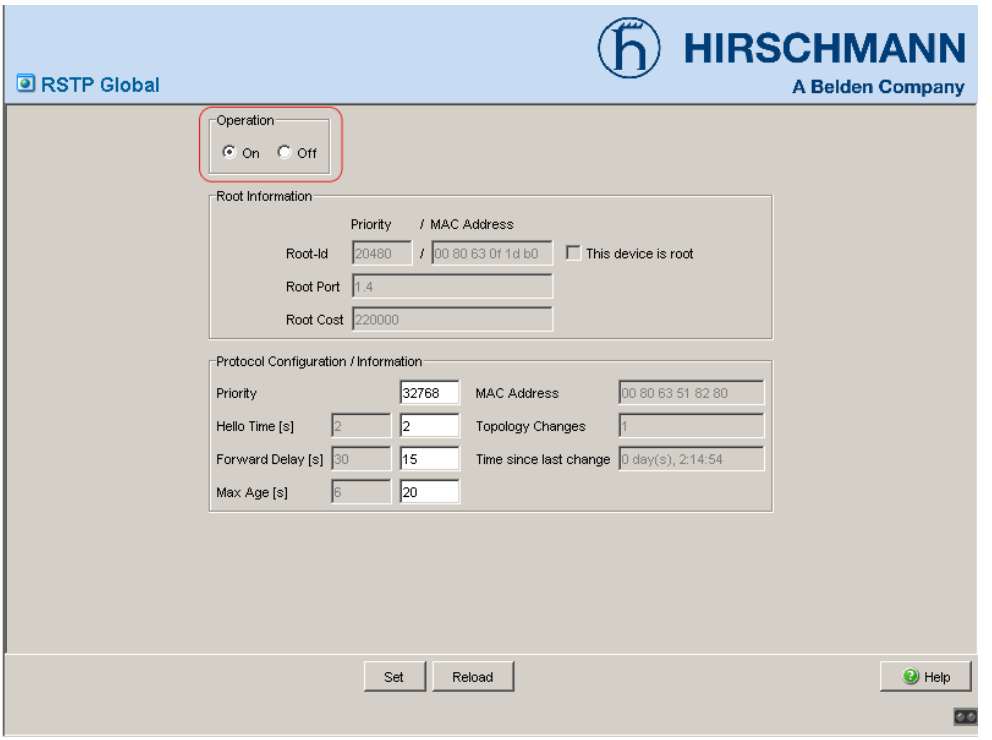


Figure 35: Operation on/off

- ☐ You now connect the redundant lines.
- ☐ Define the desired Switch as the root Switch by assigning it the lowest priority in the bridge information among all the Switches in the network, in the “Protocol Configuration/Information” frame. Note that only multiples of 4096 can be entered for this value (see table 13).
  In the “Root Information” frame, the dialog shows this device as the root.
  A root switch has no root port and no root costs.

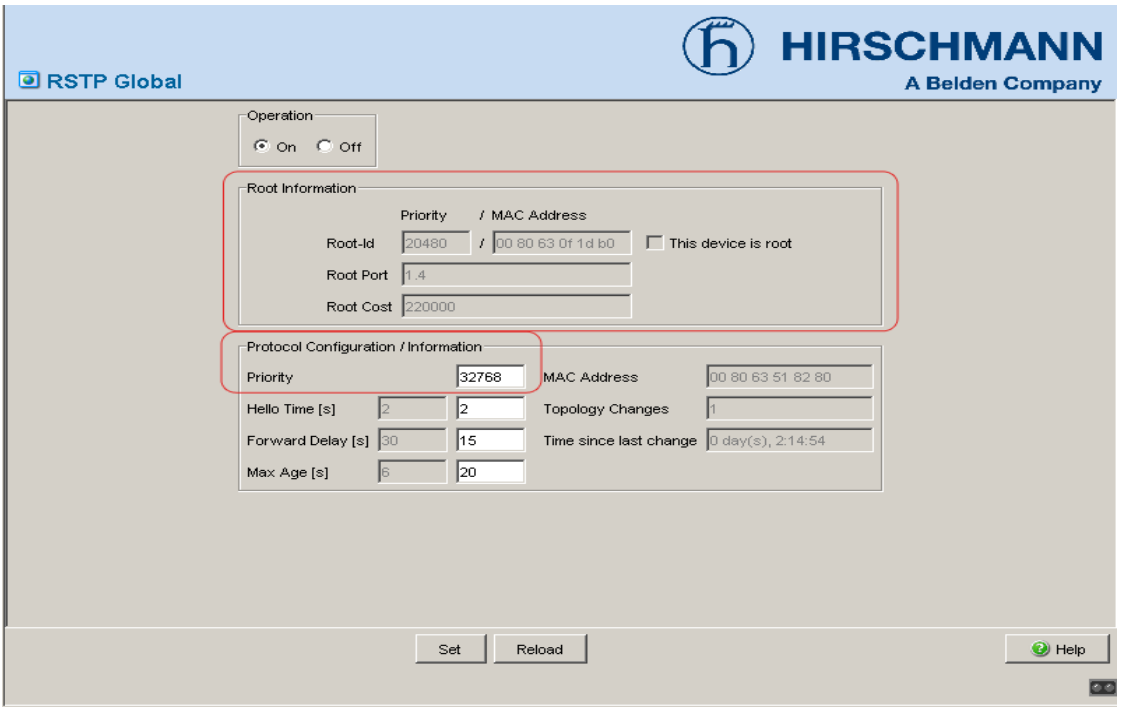


Figure 36: Assigning a priority. Display: Root Information

☐ As required, you change the default priority value of 32768 in other Switches in the network in the same way to the value you want (multiple of 4096).
For each of these Switches, check the display
in the “Root Information” frame:
– Root-Id: Displays the bridge identifier of the root Switch
– Root Port: Displays the port that leads to the root Switch
– Root Cost: Displays the root costs to the root Switch
in the “Protocol Configuration/Information” frame:
– Priority: Displays the priority in the bridge identifier for this Switch
– MAC Address: Displays the MAC address of this Switch
– Topology Changes: Displays the number of changes since the start of RSTP
– Time since last change: Displays the time that has elapsed since the last network reconfiguration

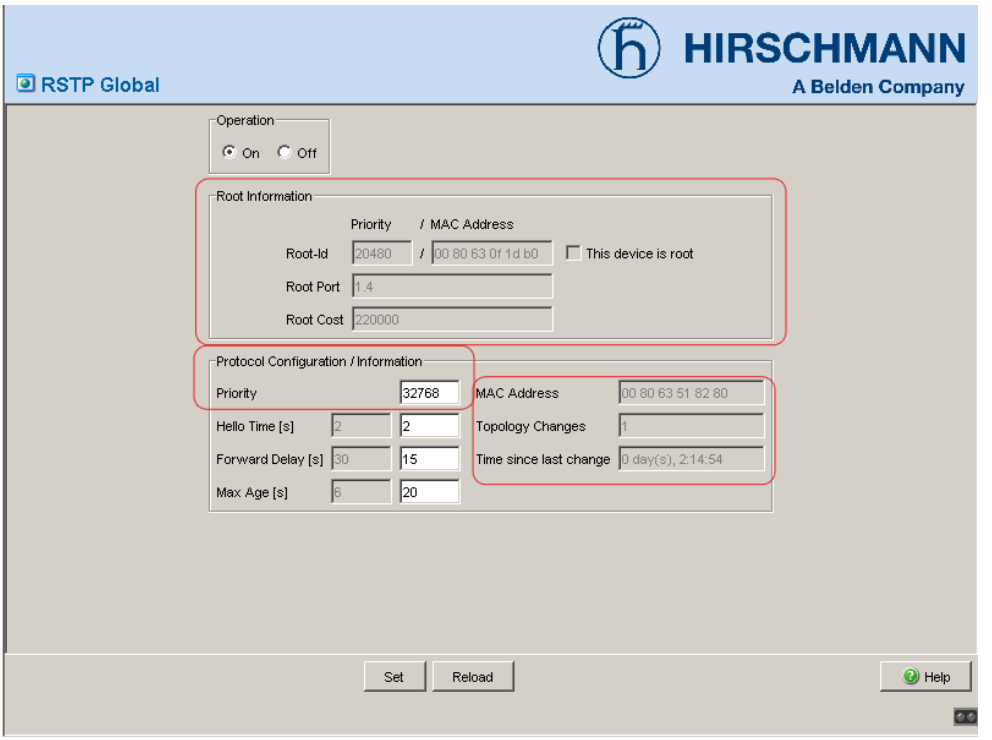


Figure 37: Display: Priority, MAC Address, Topology Changes and Time since last change

☐ If required, change the values for “Hello Time”, “Forward Delay” and “Max. Age” in the root Switch. The root Switch then transfers this data to the other Switches. The dialog displays the data received from the root Switch in the left column. In the right column you enter the values which shall apply when this Switch becomes a root Switch. For the configuration, take note of table 13.

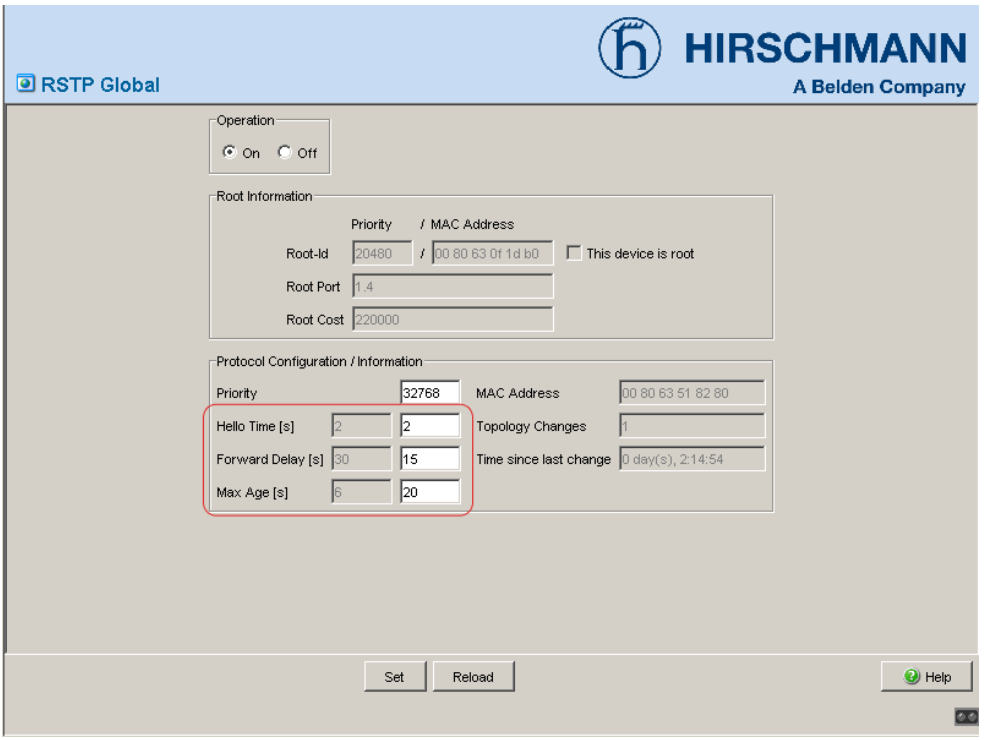


Figure 38: Assigning Hello Time, Forward Delay und Max. Age

The times entered in the dialog are in units of 1 s.
Example: Max Age = 20 corresponds to 20 seconds.

Variable	Meaning	Possible values	State on delivery
Priority	Priority and MAC address together make up the bridge identifier.	0 < n*4 096 < 61 440	32 768
Hello Time	The Switch periodically sends configuration messages (Hello packets, Configuration Bridge Protocol Data Units, CBPDU) if it is the root Switch. Hello Time is the time in seconds between the sending of two configuration messages (Hello packets, Configuration Bridge Protocol Data Units, CBPDU). This is the current value being used by the Switch.	1 - 10	2
Forward Delay	The state diagram of the Spanning Tree Protocol has four possible states: disabled, blocking, learning, forwarding. A certain amount of time passes when switching from one state to another. This is the current value being used by the Switch. The state change from forwarding to blocking occurs without a time lapse.	4 - 30	30
Max Age	After the “Max Age” elapses, a BPDU becomes invalid and is discarded.	6 - 40	6

Table 13: Global RSTP settings

☐ As required, change and verify the settings and displays that relate to each individual port (menu bar: Rapid Spanning Tree - Port).

Note: Deactivate the Spanning Tree protocol for the ports connected to a redundant ring, because the Spanning Tree and the Ring Redundancy work with different reaction times.

Variable	Meaning	Possible values	State on delivery
STP status on	Switch RSTP on/off at this port. Switch STP off when connecting a terminal device in order to avoid unnecessary waiting times. See also „Fast reconfiguration“.	on, off	on
Port state	Display of the port state	disabled, forwarding, discarding, blocking, learning (see table 12)	-
Priority	Enter the first byte of the port identifier. See also „Port Identifier“.	16 < n*16< 240	128
Admin Path Cost	Enter the path costs to indicate preference for redundant paths. If the value is “0”, the Switch automatically calculates the path costs depending on the transmission rate. See also „Bridge parameters“.	0 - 200 000 000	0
Admin Edge Port	Enter whether a terminal device (true) or an RSTP switch (false) is to be connected at this port. During reconfiguration, the edge port at a terminal device can switch to forwarding within 3 seconds. See also „Port roles“.	true, false	false
Oper Edge Port	Shows whether an RSTP Switch is connected at this port. Independently of the value set under “Admin Edge Port”, the Switch detects a connected RSTP switch. Then it sets Edge Port = false.) See also „Port roles“.	true, false	-
Oper Point-ToPoint	Shows whether at this port the connection between two RSTP Switches is a half-duplex connection (true) or not (false). (The point-to-point connection is a direct connection between two RSTP Switches. The direct, decentralized communication between the two Switches results in a fast reconfiguration time.)	true, false	auto (is calculated): FDX = true HDX = false)
Designated Root	Display of the bridge identifier of the designated root Switch for this port.	Bridge identifier (hexadecimal)	-

Table 14: Port-related RSTP settings and displays

Variable	Meaning	Possible values	State on delivery
Designated Costs	Display of the costs of the path from this port to the root Switch.	Costs (see table 11)	-
Designated Port	Display of the port identifier of the port that creates the connection to the root Switch for this port (on the designated Switch).	Port identifier (hexadecimal) and port number	-

Table 14: Port-related RSTP settings and displays

☐ You now connect the redundant lines. You can avoid loops and network failures during the configuration phase by first configuring the Switches and only then connecting the redundant lines.

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